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THE CHEMICAL

WORKS

OF

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Profeſſor of Chemiſtry at *Berlin*, F. R. S. &c.

ABRIDGED and METHODIZED.

With large Additions, Containing the later Diſcoveries and Improvements made in Chemiſtry and the Arts depending thereon,

By *WILLIAM LEWIS*, M. B.

and Fellow of the Royal Society.

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MDCCLIX.

PREFACE.

THE editor of *Neumann*'s chemical lectures published at *Zullichau*, has prefixed to them a minute detail of the author's life; in which we are informed of his being early received into the favour of the King of *Prussia*; of his travelling at his majesty's expence, to get acquainted with the chemical arts and businesses carried on in the different parts of *Europe*; of his being entertained, in this progress, by men of the most distinguished abilities in the several branches of natural knowlege; of his advancement to the public Professorship, the direction of the royal elaboratory, and apotheca at *Berlin*. How much he availed himself of these uncommon advantages, is obvious from his own writings.

THE works published by *Neumann* himself consist chiefly of dissertations on particular subjects; some in *Latin*, and inserted in the transactions of different societies and academies, of which he was a member; others in the *German* language and printed separately.

In the Philosophical Transactions of the Royal Society of *London*;

1. *Disquisitio de camphora*, N° 399.
2. *De experimento probandi spiritum vini Gallici, perquam usitato, sed revera falso & fallaci*, N° 391.
3. *De salibus alkalino-fixis*, N° 392.
4. *De camphora thymi*, N° 431.
5. *De ambragrysea*, N° 433.

In the *Ephemerides*, or *Acta physico-medica, Academiæ Cæsareæ naturæ curiosorum.*

1. *De oleo distillato formicarum æthereo*, Vol. ii.
2. *De albumine ovi succino simili*, Vol. v.

In the *Miscellanea Berolinensia*;

1. *Meditationes in binas observationes de aqua per putrefactionem rubra, vulgo pro tali in sanguinem versa habita*, Tom. iii.

2. *Succincta relatio ex actis Pomeranicis de prodigio ſanguinis in palude viſo*, ibid.
3. *De prodigio ſanguinis ex Pomerania nunciato*, ibid.
4. *Diſquiſitio de camphora*, ibid.
5. *De experimento probandi ſpiritum vini Gallicum*, &c. ibid.
6. *De ſpiritu urinoſo cauſtico*, ibid.
7. *Demonſtratio ſyrupum violarum ad probanda liquida non ſufficere*, Tom. iv.
8. *Examen correctionis olei raparum*, ibid.
9. *De vi cauſtica & converſione ſalium alkalino-fixorum aeri expoſitorum in ſalia neutra*, Tom. v.

In the *Commercium literarium phyſico-technicum medicum Norimbergenſe: Judicium & experimenta circa tincturas coralliorum*, Ann. 1735, hebd. 1747 & 1748.

Publiſhed ſeparately in *German:*

1. *Einpropfung der pocken*, Berlin, 1727.
2. *De ſalibus alkalino-fixis & camphora*, Berlin, 1727.
3. *De ſuccino, opio, caryophyllis aromaticis, & caſtoreo*, Berlin, 1730.
4. *Vom ſalpeter, ſchwefel, ſpieſsglaſs, und eiſen*, Berlin, 1732.
5. *Vom thee, coffee, bier, und wein*, Leipſic, 1735.
6. *Diſquiſitio de ambra gryſea*, Dreſden, 1736.
7. *Vom gemeinen ſaltz, weinſtein, ſalmiac, und der ameiſe*, Leipſic, 1737.

THE foregoing are all the writings of *Neumann* publiſhed in his lifetime. Since his death two copies of his chemical lectures have appeared.

The firſt conſiſts of notes taken down by one of his pupils, intermixed with a number of incoherent compilations from different authors. This is intitled *Herr D. Caſpar Neumann's, geweſenen königl. Preuſſiſchen Hofraths und profeſſoris publici chemiæ practicæ &c. Prælectiones chemicæ, ſeu chemia medico-pharmaceutica experimentalis & rationalis---herauſgegeben von D. Johann Chriſtian Zimmermann medicinæ practico in Schneeberg.* Berlin, 1740. 2 vol. quarto—pages 1872, excluſive of prefaces and index—Of this copy a ſecond edition has been publiſhed, not materially different, ſo far as I have obſerved, from the former, though *Neumann's* name is omitted in the title page, which in this new edition is as follows: *Allgemeine grundſätze der theoretiſch-practiſchen chemie, das iſt, gründlicher und vollſtändiger unterricht der chemie; in welchem nicht nur überhaupt eine gründliche anleitung zu allen theilen der chemie, ſondern auch die—operationes und producta—mit demonſtrationibus und experimentis—gelehret werden; nebſt beygefügten mediciniſchen, chirurgiſchen, oeconomiſchen, metallurgiſchen, &c. gebrauch und anwendung. Herauſgegeben von D. Johann Chriſtian Zimmermann.* Dreſden, 1755—2 vol. quarto—pages 1604.

The

The other copy is printed by the bookſellers of the orphan hoſpital of *Zullichau* (the city of *Neumann*'s birth) and ſaid to be taken from the original papers in the Author's own hand-writing. This alſo has had two impreſſions; one of which is an abridgement of the other, from ſeven Volumes in Quarto into two, from upwards of 7000 pages into 2560, under the following title: *D. Caſpar Neumann's, chemahligen königl. Preuſſiſchen Hofraths, profeſſoris der chemie, &c. Chymia medica, dogmatico-experimentalis, das iſt, grüindliche und mit experimenten erweiſene mediciniſchen chymie. Zullichau*, 1756.

The editor of this abridgement obſerves, that *Neumann*'s writings are extremely voluminous, and that therefore he has endeavoured to reduce them, in ſuch a manner as not to mutilate the ſenſe, but to give the whole of the proceſſes, experiments and obſervations in the Author's own words. So ſcrupulouſly has this abridger fulfilled his taſk in this reſpect, that he has in general not ventured to contract *Neumann*'s diffuſe manner of writing, or rather ſpeaking to his audience. Much of the work is ſtill taken up in a minute account of medicinal preparations many of which are not uſed; in the formal refutation of theories and opinions not now received; in narratives and diſcuſſions often foreign to the ſubject and frequently frivolous in themſelves. An account of the apparatus of the tea-table, and the manner of making tea, fills a quarto page and a half of this abridgement.

The general arrangement of the materials, excluſive of the minute and trifling ſubdiviſions, is likewiſe very exceptionable. Thus the chemical products or preparations *, which make the two firſt parts, being

* The general diſtribution of the chemical preparations is as follows.

Part I. Of liquid preparations.

Sect. I. Of waters.
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Chap. 2. Of compound diſtilled waters.
Chap. 3. Of waters not diſtilled.
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Chap. 3. Of ſimple diſtilled inflammable ſpirits.
Chap. 4. Of compound diſtilled inflammable ſpirits.
Claſs II. Of ſaline ſpirits.
Chap. 1. Of urinous ſaline ſpirits.
Chap. 2. Of vegetable acid ſpirits.
Chap. 3. Of ſimple mineral acid ſpirits.
Chap. 4. Of compound mineral acid ſpirits.
Claſs III. Of oily ſaline ſpirits.
Chap. 1. Of oily alkaline ſaline ſpirits.
Chap. 2. Of oily acid ſaline ſpirits.
Chap. 3. Of compound oily ſaline ſpirits.
Sect. III. Of tinctures.
Claſs I. Of acid tinctures.
Chap. 1. Of watery acid tinctures.
Chap. 2. Of ſpirituous acid tinctures.
Claſs II. Of alkaline tinctures.
Chap. 1. Of tinctures made with fixt alkali.

Chap.

being divided into liquid and ſolid; volatile ſpirits are placed in the one part, and the ſalts in the other; though they ought naturally to come together,

Chap. 2. Of tinctures made with volatile alkali.
Claſs III. Of neutral tinctures.
Chap. 1. Of thin neutral tinctures.
Chap. 2. Of thick neutral tinctures.
Claſs IV. Of alkaline oily tinctures.
Chap. 1. Of ſimple alkaline oily tinctures.
Chap. 2. Of compound alkaline oily tinctures.
Claſs V. Of oily or reſinous tinctures.
Sect. IV. Of eſſences.
Sect. V. Of elixirs.
Sect. VI. Of ſaline ſolutions.
Sect. VII. Of oils.
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Part II. Of ſolid preparations.

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Subdiviſion 2. . . . . more earthy.
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2. . . . . mineral.
1. . . . with the acid of common ſalt.
2. . . . with the acid of nitre.
3. . . . with the acid of vitriol.
Subdiviſion II. more earthy fixt neutral ſalts.
Subdiviſion III. Fixt neutral ſalts in the dry way.
1. . . . pure
2. . . . more earthy.
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Chap. 3. . . . from perfect metals.

Claſs

together, the ſpirit being no other than a ſolution of the ſalt in water. The chemical ſubjects (which compoſe the other three parts, under the heads of vegetables, animals, and minerals) are ranged for the moſt part alphabetically; each article being conſidered as one ſeparate whole, and not as making part of a larger ſtructure. So ſcrupulouſly is the order of *Neumann*'s lectures preſerved, that where he deferred a ſubject to a future meeting, on account of his experiments upon it not having been finiſhed at the time when he ought to have ſpoken of it, the ſubject continues miſplaced in all the editions.

Neumann's lectures are a valuable magazine of chemical knowledge. The Author, biaſſed by no theory, and attached to no opinions, has enquired by experiment into the properties and uſes of the moſt conſiderable natural and artificial productions, and the preparation of the principal commodities which depend on chemiſtry; and ſeems to have candidly, and without reſerve, communicated all he diſcovered.

THE merit of this work, ſo much celebrated in *Germany*, and ſo little known here, engaged me to reviſe and abridge an *Engliſh* tranſlation, and to make ſuch additions as appeared neceſſary for ſupplying the deficiencies of the Author.

In regard to the original, the *Zullichau* edition has been followed; the abrupt tranſitions and mutilated ſentences of the other ſhewing it to be of no authority. In the contraction, I found it neceſſary to proceed much further than the abridger of *Zullichau* has done, and to take ſome liberties not perhaps very common in performances of this kind. It ſeemed requiſite, not ſo much to retrench the trivial and redundant, as to extract and digeſt the uſeful matter. Accordingly I have ventured to new mould the whole fabrick; and hope it will appear, that all the valuable materials, ſcattered through *Neumann*'s, writings are collected and diſpoſed with propriety.

I have added by way of notes, the later diſcoveries and improvements made in chemiſtry and the arts depending thereon. Much of this

Claſs III. Of ſulphureous magiſteries.
Claſs IV. Of reſinous magiſteries.
Claſs V. Of compound magiſteries.
Claſs VI. Of falſe magiſteries.
Sect. VI. Of calces and croci.
Claſs I. Of animal calces.
Claſs II. Of mineral calces.
Chap. 1. Of ſimple mineral calces.
Chap. 2. Of compound mineral calces.
Sect. VII. Of glaſſes.

Part III. contains the vegetable, Part IV. the animal, and Part V. the mineral ſubſtances, examined by the Author. It is needleſs to inſert the alphabetic catalogues of them, as the table of contents of the preſent work conſiſts of the ſame articles, ranged in a more ſcientific method; a method which *Neumann* himſelf has in different parts of his writings pointed out.

part

part of the work is taken from the writings of others and not a little from the diaries of my own elaboratory.

THE index is to be conſidered not barely as a table of references, but as a ſummary of the moſt conſiderable facts, which are there repreſented commonly in a new light. Several facts are mentioned in the index which though deducible by analogy from the experiments in the pages referred to, could not on that foundation alone be looked upon as certain. There are even ſome facts which have no reference at all, and which are not mentioned in the book. Thus Acacia, an inſpiſſated vegetable juice, prepared in *Egypt*, rarely met with among us, uſed in medicine as a mild aſtringent, is omitted by the author; and ſuch an article did not ſeem to be of importance enough to be introduced: But on taking a review of the *aſtringency* of vegetables in the index, the light in which this quality appeared there made Acacia worthy of notice; for as among the vegetables examined by the author, the aſtringency of ſome diſſolves both in water and in ſpirit, and that of others in ſpirit only; Acacia is an inſtance of a third kind of aſtringent matter, diſſolving in water only.

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PART I.

CHEMICAL HISTORY

OF THE

MINERAL KINGDOM.

SECTION I.

EARTHS *and* STONES.

EARTHS and Stones are considered by naturalists as two distinct classes of bodies: And each of them arranged, from certain obvious appearances, as colour, consistence, external figure, texture, *&c.* into numerous subdivisions. A chemical examination has discovered, that many of these apparently very different bodies are, in their essential properties, the same; and that many of those, which are apparently similar, are essentially very different. Thus the softest Chalk, the hardest Marbles, the most pellucid Spars, are found to be at bottom one and the same Earth: fire reduces them all into Quick-lime; Acids dissolve, and form with them indistinguishable compounds. And on the other hand, the Talcs and Gypsums, though some of them are externally so much alike as to have often been confounded with one another and called by the same name, consist of Earths entirely distinct: one resists the most vehement fires, whilst the other, in a very moderate heat, seems to liquefy and boil, and changes into the substance called Plaster-of-Paris: the latter, burnt in contact with the fuel, dissolves readily in Acids, whilst the former, treated in the same manner, continues to resist every kind of humid *Menstruum*.

EARTHS. Common division of Earths and Stones, superficial.

EARTHS. Stahl, diſregarding ſuperficial and ineſſential characters, formed a diſtribution of Earths and Stones from their chemical properties. He divides them all into two claſſes, Vitreſcible and Calcareous; the firſt comprehending thoſe which have a greater or leſs degree of tranſparency, and are diſpoſed to vitrify in the fire; the other, ſuch as are opake, become brittle or hard in the fire, and reſiſt vitrification. This arrangement, though an uſeful one, is in ſeveral reſpects exceptionable, and requires further diſtinctions and limitations.

Chemical diſtribution of them. "Experiments have ſhewn, that there are four kinds of Mineral Earths, diſtinct from one another, the Cryſtalline, Calcareous, Argillaceous and Talky; to which may be added a fifth ſort of earthy concrete, the Gypſeous. All the earthy and ſtony bodies of the Mineral Kingdom, that have been chemically examined, are found to conſiſt of theſe, not often in their ſeparate or pure ſtate, but for the moſt part variouſly blended together, and combined with metallic or other heterogeneous matters.

Each of the ſimple Earths, and the gypſeous Concrete, ſuſtains, by itſelf, the moſt vehement degrees of Fire that art has hitherto been able to excite, without ſhewing any diſpoſition to melt or ſoften: Two or more of them, mixed together, oftentimes melt in a moderate fire, and form a truly vitreous compound. This remarkable property is a proof of the intrinſic diſſimilarity of the Earths; for we cannot ſuppoſe that an unfuſible ſubſtance would be brought into fuſion by the bare addition of its like. It follows alſo, that fuſibility, though uſually looked upon as a character of one particular ſpecies of ſimple Earth, is really a character of compoſitions of Earths, and belongs equally to a great variety of combinations of them.——The ſimple Earths are brought into fuſion by the addition of certain Salts and metallic calces: and ſuch mixtures of Earths, as do not melt by themſelves, melt with a leſs proportion of theſe fluxes than the ingredients ſeparately would require. The different Earths differ remarkably in their relation to theſe bodies; ſome entirely reſiſting thoſe which are moſt powerful fluxes for others——It may be proper to obſerve, that the reſult of the fuſion of Earths, by whatever means effected, is conſtantly a vitreous matter. Some metallic calces and glaſſes would not eaſily be diſtinguiſhable from thoſe of Earths, if the metallic ones were not revivable by inflammable fluxes into their proper metallic ſtate."

CLASS I. CRYSTALLINE STONES.

Stony bodies of great hardneſs, capable of ſtriking fire with Steel;—by vehement heat and extinction in water, becoming brittle, friable, or powdery:—not acted upon in the leaſt by Acids, either in their natural ſtate or when calcined.

I. FLINT.

FLINT. Natural Hiſtory. THE Flint is a ſemitranſparent ſtone, generally covered with an opake white cruſt. Its colour varies, from a pale browniſh grey, to a dark browniſh black: its texture is always ſmooth and uniform; its figure irregular. Thoſe found in the beds of rivers, or thrown out upon the ſea-ſhores,

are commonly the moſt pure from heterogeneous admixtures: the Land-Flints have often ſpecks or ſtreaks of a reddiſh ferrugineous matter, diſcoverable chiefly after they have been burnt or calcined. In ſome there are veins of native gold: One of the moſt curious ſpecimens of this kind is in the cabinet of his Pruſſian Majeſty. FLINT.

The ſparks which iſſue from the colliſion of Flint and Steel, collected upon Paper and viewed with a microſcope, appear to be globules of vitrified matter: A chemical examination diſcovers that they contain more of the Iron than of the Flint, changed into a kind of glaſſy Scoria (*a*).—Two Flints ſtruck againſt one another, project no viſible ſpark; nor do the fragments broke off ſeem to have ſuffered any change: But the Stones themſelves appear, in the dark, luminous; ſome throughout the whole maſs, others only on the ſide ſtruck upon. The greater number of Flints I have examined is of this laſt kind. Sparks from Flint and Steel examined. Phoſphorus.

Boerhaave relates, that Flint, placed in the focus of Villette's burning ſpeculum, was inſtantly converted into glaſs. I have had no opportunity of trying that inſtrument; but have expoſed Flint to the action of the large burning lens of Tſchirnhaus, without being able to produce any ſuch effect. Though Flint, however, by itſelf, abſolutely reſiſts that moſt vehement heat, and Quick-lime by itſelf equally reſiſts it; yet a mixture of the two runs with eaſe into glaſs (*c*). Flint at a burning glaſs. Melted with Lime.

Powdered Flint, mingled with a due proportion of fixt Alcaline Salt melts eaſily in the common furnaces, and forms the baſis of the fine white cryſtalline kinds of Glaſs, and of the compoſitions for imitating precious ſtones (*b*). Kunckel recommends the Sea-flints, as yielding a finer Glaſs, and requiring leſs Salt, than thoſe found on the land: Others object to the marine Vitrification with Salts.

(*a*) *Sparks from Flint and Steel.*] It does not appear that the Steel is here really vitrified, or that the heat produced is ſo intenſe as has been generally ſuppoſed. Among the particles of metal abraded by the Flint, there are indeed ſome globular ones which have evidently been melted: but the magnet ſtill attracts them; a mark that they are not ſcorified, but continue perfectly metallic. The fuſion of ſmall moleculæ of Steel does not require any very extraordinary heat: if fine Steel-wire be held barely in the flame of a candle, the end will melt, and form a little ball like thoſe obtained in the experiment of ſtriking fire with Flint.

(*b*) *Vitrification of Flint.*] Of all the ſaline matters that have been tried in compoſition with Flint, fixt alcalies moſt effectually promote its vitrification: two parts of the Alcali and three of Flint, urged with a ſtrong fire, form a perfect glaſs. Borax, by vehemence of heat, may be made to vitrify twice its weight, and even more; but the compound ſcarcely proves tranſparent, unleſs the Borax be equal in quantity to the Flint: a ſmall addition of Alcaline Salt to this mixture promotes both the fuſion and tranſparency: the glaſſes made with Borax, or with Borax and a little Alcali, prove rather harder than thoſe with the Alcaline Salt alone—Common Salt, Sal mirabile and Sandiver, are remarkably indiſpoſed to vitrify with Flint, though taken even in twice or thrice the quantity of the Stone: nor do they, in any proportions, form with it a pellucid glaſs.

(*c*) *Vitrification of Flint with other earths.*] Powdered Flint has been mixed in different proportions both with Quick-lime and with Earths of each of the other claſſes, and urged with the moſt intenſe fires procurable in the common furnaces, without ſhewing any diſpoſition to melt: but theſe mixtures

FLINT. marine Flints, that they make the Glaſs brittle and apt to crack. Thoſe which exhibit red veins when calcined, ſhould either be rejected, or freed from that extraneous matter, which would give a tinge to the Glaſs: This may be effected by waſhing the powder with Spirit of Vitriol or Aqua Regis, and afterwards edulcorating it with water. Such as have been pulveriſed in an iron mortar ſhould likewiſe be purified by the ſame means from the ferrugineous particles they may have abraded from the inſtrument, before they are employed in the compoſition of any curious Glaſs. White Sand is often ſubſtituted in the place of Flint, and does not conſiderably differ from it in quality (*d*). Calces of Lead are commonly added, for the colourleſs as well as coloured glaſſes, to promote the vitrification.

Diſſolved in Alcalies. Though a moderate proportion of fixt Alcaline Salt unites with Flint, in the fire, into a perfect glaſs, which is not diſſoluble in any liquor, and diſcovers no mark of a ſaline nature; a ſomewhat larger proportion of the Alcali changes the Flint itſelf into an apparently ſaline form. If powdered Flint be mixed with thrice, twice, or even equal its weight of fixt Alcaline Salt, and the mixture melted in a crucible; the maſs, though it has a vitrious appearance, proves in taſte ſaline and fiery, like the Alcali itſelf; and on being expoſed to the air, runs in a little time, Flint and all, into a colourleſs tranſparent liquor, called *Liquor ſilicum*, or *Oleum ſilicis per deliquium* (*e*).

Coagulation of Liquids. This liquor, on being mixed with mineral Acids, particularly the Vitriolic, inſtead of effervеſcing and uniformly mingling with them, as mere Alcaline Liquors do, grows inſtantly thick, and in ſome degree ſolid; as if the diſſolved Flint was going to reſume its original conſiſtence. It coagulates

mixtures are brought into fuſion by a much leſs proportion of Salt than the ingredients ſingly would require. Though Alcalies are the moſt powerful flux for Flint by itſelf, Borax is found moſt effectually to vitrify the compounds.

(*d*) *Sand.*] Though the fine white Sands appear to the eye to be purer than Flint, they ſcarcely afford ſo clear a glaſs: the difference is the moſt perceptible when each of them is melted with a ſomewhat ſmaller proportion of Alcali than is ſufficient to bring them to their full tranſparency. Pott relates, that on melting Sand with half its weight of Nitre, he obtained a glaſs of a purple colour; probably from ſome metallic matter, of which moſt Sands participate in a greater or leſs degree.

The red and yellow Sands are manifeſtly impregnated with a ferrugineous calx. They contain alſo a minute portion of Gold; which is ſeparable from them in the way of aſſay, though no method has hitherto been found of extracting it to advantage in the larger works. Cramer and others preſume, that there is no Sand in nature entirely free from Gold. See *Gold.*

(*e*) *Deliquiation of Flint and Alcali.*] The proportion of Alcaline Salt for obtaining with Flint either a deliquiable or a truly vitreous compound, depends greatly on the degree and continuance of the fire. A mixture of powdered Flint with an equal quantity of the Salt, if taken out of the furnace as ſoon as it appears melted, will liquefy by degrees upon expoſure to the air: but if the fire is kept up ſtrong for ſeveral hours, though the quantity of Salt be more than doubled, the reſult will be a perfect and durable glaſs; all the ſuperfluous Alcali being diſſipated by the vehemence of the heat. One part of Alcali and two of Flint have been ſaid to deliquiate: But this mixture requires a very ſtrong fire for its fuſion; and when perfectly melted, proves a ſemitranſparent glaſs, of conſiderable hardneſs, ſo as freely to ſtrike fire with Steel. Glaſs in general is found to be harder in proportion as it contains leſs Salt.

lates alſo with metallic ſolutions made in Acids; that of Corroſive Sublimate, or of Mercury in the Marine Acid excepted; this ſolution yielding with the *Liquor Silicum*, as with pure Alcalies, an orange yellow Precipitate, and ſcarce diſcovering any tendency to become curdly. It likewiſe becomes conſiderably thick or conſiſtent, with ſome ſolutions of Earths in Acids, as that of Quick-lime in the marine. If loaded with the Flint, as the liquor prepared from equal parts of Flint and Alcali, it grows thick, upon ſtanding for ſome time, without any addition. The coagulum which it forms with ſolution of Mercury in the nitrous Acid appears variegated, reddiſh, yellowiſh, and grey: the others are more uniform (*f*). FLINT.

There have been many pretences of extracting from Flint, Salts, Spirits, Tinctures, *&c.* and many preparations of it recommended by the Chemiſts, both for medicinal and the ſublimer metallurgic uſes; from a groundleſs conceit, that this Stone was poſſeſſed of lithontriptic powers, and impregnated with a ſolar Sulphur. It has been ſaid that Flints, by repeated ignition and extinction in water, change at length into a ſlimy ſubſtance, from which may be procured, by diſtillation, a Spirit and an Oil: Becher, Stahl, Henckel and others mention this proceſs, and promiſe notable effects from it on metallic bodies: But upon trial, an hundred repetitions of the extinction made no other change in the Flint than rendering it friable; nor did the water, in which the ignited Stone had been ſo often quenched, appear to have received from it any impregnation, which ſome pretend it does, or to differ ſenſibly from the pure water employed. Glauber and others recommend diſtilling the Flint with equal its weight or more of fixt Alcaline Salt: this mixture, if the fire is raiſed high enough to melt it, emits vapours reſembling thoſe of the acid of Sea-Salt: The maſs, deliquiated in the air, emits vapours of the ſame kind on the affuſion of Oil of Vitriol: It does not however follow that the marine Acid, extricated in theſe experiments, exiſted in the Flint; the Alcali, without the Stone, yielding the ſame marine vapours.

If any Acid exiſts in Flints, it ſhould ſeem to be the Vitriolic; and that they contain a portion of this, there is ſome foundation to preſume. If Flints be mixed with Nitre, and expoſed to a moderate fire, the Acid of the Nitre will be remarkably extricated; the known effect of the Vitriolic Acid alone. In a ſtrong fire indeed, the Flint as an Earth would expel the nitrous Spirit; by abſorbing and vitrifying with its alcaline baſis: but here the extrication happens long before the heat has been raiſed high enough for vitrification (*g*). Contains Vitriolic Acid.

II. CRY-

(*f*) *Liquamen of Flints.*] The Flint is precipitated from this ſolution of it in fixed Alcalies, not only by Acids, but likewiſe, as the German editor obſerves, by Volatile Alcalies. The Earth thus recovered either by one or the other is found to be remarkably altered; to be now diſſoluble in Acids which it entirely reſiſted before. Sand and Cryſtal ſuffer the ſame change—Whether this effect is owing to a change made in the earth itſelf, or the ſeparation of any particular matter from it, has not hitherto been examined though highly deſerving of enquiry.

(*g*) *Probably Vitriolic Acid in Flint.*] In the making of common Glaſs with Flint, when the quantity of matter is large, a ſaline ſubſtance ariſes to the ſurface during the fuſion, commonly called Sandiver or Glaſs-gall: this, though no Vitriolic Salt was employed in the compoſition, is found to participate largely of that Acid, and to be nearly ſimilar to Sal Mirabile. Did the Vitriolic Acid pre-exiſt in the Flint, or was it generated during the proceſs?

II. CRYSTAL.

CRYSTAL. Natural history.

CRYSTAL is one of the hardeſt Stones next to the Gems (*b*): by ſome it has been ranked in that claſs. It is ſometimes colourleſs and pellucid as Glaſs; though often tinged of a yellowiſh, browniſh, or other colours. It is generally of a regular figure, namely that of an hexagonal column with unequal ſides, terminated by an hexagonal pyramid: in rivers, it is ſometimes found with the angles rounded off, and ſometimes quite round. The maſſes are commonly ſmall, though ſometimes of conſiderable magnitude: In the Breſlau Collections for the year 1725, there is an account of a piece of Cryſtal found near Zittau, and thence brought to Dreſden, which weighed upwards of four hundred weight: In the Imperial Collection at Vienna, there is a pyramidal

(*b*) *Gems.*] The Gems or precious Stones are the hardeſt of all natural bodies. Art has imitated moſt of them in other reſpects; but no artificial compoſition comes near them in point of hardneſs. They have been ſuppoſed to be entirely unſubduable by common fire; but experiment ſhews, that they calcine and become pulverable like the other Stones of this claſs, though more difficultly in proportion to their greater hardneſs. The Diamond itſelf, as Pott obſerves, in a vehement fire, loſes all its luſtre and tranſparency, becomes milky, friable, and ſplits into fine leaves like Talc. The Hyacinth and Garnet come at length into actual fuſion; changing their red colour to a dark black, but preſerving even in this form a great degree of hardneſs: Both the colour and the fuſibility of theſe Stones appears to proceed from Iron, a portion of which is ſeparable from them by the Magnet. The blue tincture of the Sapphire, the purple of the Amethyſt, and the green of the Emerald, are more periſhable; being totally deſtroyed by a moderate degree of heat, ſo as to leave the Stones colourleſs as Cryſtal. The Emerald, in loſing its colour in the fire, tinges the flame bluiſh.

Mr. Pott, in the Berlin Memoirs, has given a curious ſett of experiments on the Saxon Topaz, which is reckoned the hardeſt of all the Stones, except the Diamond, Sapphire and Ruby. This Stone, reduced to powder after repeated ignitions and extinctions, refuſed to melt with even ten times its weight of fixt Alcaline Salt; great part of the Alcali tranſuding through the crucible, inſtead of acting upon the Topaz. A portion of Sea-Salt was added to the Alcali without any better ſucceſs; but on adding Borax, the caſe was altered: two parts of Topaz, with no more than one of Alcali and one of Borax, melted into a tranſparent glaſs, in colour inclining to yellow. On taking Nitre inſtead of Alcaline Salts, the event was the ſame: in whatever proportion Topaz and Nitre were mixed, they reſiſted vitrification; but by the mediation of a proper quantity of Borax, they melted perfectly together. Borax alone alſo was found to bring the Topaz into fuſion, and this even when the quantity of the Borax was no greater than one half of that of the Stone. The powdered Topaz, mixed with thrice its weight of Chalk, vitrified, in a vehement fire, without any ſaline addition at all. It melted likewiſe, not only with the fuſible Calces of Lead, but with the unfuſible ones of Copper.

The Topaz appears from theſe experiments not to conſiſt wholly of Cryſtalline Earth; ſince the pure Cryſtalline Earth vitrifies more eaſily with Alcaline Salts than with Borax, and does not vitrify at all with Chalk. Any of the other ſimple Earths, mixed with the Cryſtalline, renders it more eaſily fuſible with Borax than with Alcali; but the only one that renders it fuſible with Chalk is the Argillaceous: hence it is not unreaſonable to ſuſpect, that the precious Stones are compoſed of the Cryſtalline Earth mixed with the Argillaceous. If this ſhould be the caſe, the proportion of Argillaceous Earth cannot be large; for if it was, the Stone, inſtead of growing friable, would gain additional hardneſs in the fire.

dal Cryſtal Vaſe two ells in height, cut wholly out of one piece—— Pieces are ſometimes met with, which have different foreign bodies included within them: I have ſeen leaves and ſtalks of Plants, Hay, Straw, Hogs Briſtles, incloſed in ſprigs of Cryſtal. CRYSTAL.

Cryſtal is ſomewhat more difficultly fuſible than Sand, and is ſaid to afford a ſomewhat harder Glaſs: it requires by itſelf about an equal weight of Alcali for its vitrification; of Borax, if mixed with a little Lapis Specularis, a ſmaller proportion proves ſufficient. With half its weight of Alcali, it formed a violet blue maſs: by varying the proportions, I have obtained brighter and darker blues, and browniſh red compounds (*i*). Like the other bodies of this claſs, it reſiſted the ſolar heat, and ſaline Menſtruums; and gave no impregnation to Water on being repeatedly quenched in it. Becher pretends to reduce it into the conſiſtence of a Jelly, that ſhall flow in a moderate heat like Wax. Vitrification.

Cryſtal may be tinged of a variety of colours, by expoſing it in a cloſe crucible to the vapours of Orpiment, or of Antimony and Arſenic (*k*); or by quenching the ignited Stone in coloured liquors: Tincture of Cochineal gives a bright red; Tincture of red Saunders, a dark red; Tincture of Saffron, according as it is more or leſs ſaturated, a dark and a bright yellow; Solution of Lacmus, a bright blue; Juice of Buckthorn Berries, a violet blue; a mixture of Solution of Lacmus and Tincture of Saffron, a green. Methods of colouring.

CLASS

(*i*) *Blue and reddiſh maſſes from Cryſtal.*] Probably the Cryſtal, employed in theſe experiments participated of cupreous or other heterogenous tinging matters, for pure Cryſtal gives a colourleſs Glaſs. That this Glaſs is either harder or more tranſparent than ſuch as is made from Flint, as it is commonly ſuppoſed to be, did not appear upon compariſon.

(*k*) *Colouring of Cryſtal.*] This method of colouring Cryſtal was firſt deſcribed by Neri in his art of Glaſs *. He directs Antimony and yellow Orpiment of each two ounces, and one ounce of Sal Ammoniac, to be mixed together and put into a crucible; and ſome pieces of clear Cryſtal to be laid above the mixture, the ſmaller ones at the bottom and the larger at top, till the veſſel is full: another crucible, having a ſmall hole in its bottom, is to be inverted into the former by way of cover, and the juncture cloſely luted: the whole is then to be placed in a convenient furnace, and ſurrounded with charcoal to about half the height of the upper crucible: the fire is to be raiſed by degrees, kept up, gentle, till the fumes diſappear, and then ſuffered to go out of itſelf; care being taken to avoid the poiſonous vapours: the uppermoſt pieces of Cryſtal are found tinged with Gold, Ruby, Opal, and other beautiful variegations; and moſt of the lower ones of a viper colour. He gives another proceſs, in which the ingredients are, yellow Orpiment and white Arſenic of each two ounces, and Crude Antimony and Sal Amoniac of each one ounce. ——The Cryſtal, in theſe operations receives very elegant colours, but is apt to become full of cracks, and hence unfit for being cut or poliſhed. Kunckel ſuppoſes the colour to be wholly owing to the Fiſſures of the Stone retaining the colouring particles: but though this is often, it is not always the caſe, ſome pieces being tinged throughout, without any viſible fiſſure: his own words inſinuate, that ſome receive the full tincture, without thoſe imperfections. I have known bodies of the Cryſtal kind, or at leaſt equal to Cryſtal in compactneſs and tranſparency, penetrated above an inch by certain vapours, though not the leaſt fiſſure or imperfection could be diſcerned.

* Book iv. Chap. 73.

CLASS II. CALCAREOUS EARTHS *and* STONES.

Earths and ſoft Stones,—reducible by fire into Quick-lime;—readily ſoluble in the nitrous, marine, and vegetable Acids, both in their natural ſtate and when calcined.

I. CHALK.

CHALK. Natural Hiſtory.

CHALK is a white Earth, found plentifully in England, France, Norway, and other parts of Europe; ſaid to have been anciently dug chiefly in the iſland Crete or Candy, and to have thence received the name *Creta*. Some attribute the excellency of the grapes and the wines of Champagne to the chalky ſoil abſorbing acid juices; a theory which would be abundantly plauſible, if the unripe grapes had no acidity.

The beſt Chalk is of perfect whiteneſs, ſoft yet cloſe and ſolid, equal and uniform when broke, free from Sand or ſmall Stones. Powdered, and waſhed over from any gritty matter that may be naturally intermixed, it is called Whiting; and in this ſtate is beſt adapted for medicinal and chemical uſes, as well as the œconomical ones of cleaning and poliſhing metalline or glaſs utenſils, *&c.* Chalk readily imbibes water; and hence maſſes of it are employed for drying Precipitates, Lakes, earthy powders that have been levigated with water, and other moiſt preparations.

With Acids. Oil of Vitriol poured upon Chalk raiſes a ſtrong efferveſcence with a bituminous vapour, but ſcarcely diſſolves any of the Earth: if more and more of the Acid be gradually added, the whole continues quiet, without any further conſiderable efferveſcence or ſolution. If the Acid be diluted with water, it diſſolves ſome portion of the Chalk (*l*). All the other Acids readily and totally diſſolve it: four ounces of Spirit of Nitre took up one ounce; the ſame quantity of Spirit of Salt, ſix drams; and the ſame quantity of diſtilled Vinegar, three drams. The action of the nitrous Acid was accompanied with a conſiderable frothing, but no heat or red fumes.

Solutions of Chalk in the nitrous and marine Acids, are extremely bitter; thoſe made in diſtilled Vinegar are much leſs ſo. None of them perfectly cryſtallize; nor, if inſpiſſated, do they long retain a dry form: how carefully ſoever they be exſiccated by fire, they deliquiate again in the air, though one more

(*l*) *Chalk with the Vitriolic Acid.*] Chalk does not diſſolve, or but in ſmall quantity, in the Vitriolic acid whether concentrated or diluted. This Acid has nevertheleſs a very ſtrong affinity with Chalk; abſorbing it from all the other Acids, and forſaking even Alcaline Salts to unite with it. If this Earth be diſſolved in Spirit of Nitre, Spirit of Salt, or diſtilled Vinegar; the addition either of the pure Vitriolic Acid, or of compound Salts containing it, renders the liquor inſtantly milky or curdly; the Chalk being now combined with that Acid into a concrete not at all, or exceeding ſparingly, diſſoluble. If the Solution of Chalk be largely diluted with water before the addition of the Vitriolic Spirit, the liquor continues for a time tranſparent: on ſtanding it becomes wheyiſh, and at length depoſites cryſtalliform concretions, which are found to be true Selenitæ or gypſeous Maſſes; being indiſſoluble in Acids, calcining in veſſels into Plaſter, and in contact with the fuel into Quick-lime.

more readily than another. It has been ſaid, that Chalk forms with the Vitriolic Acid a perfect Alum: It may indeed be combined with that Acid into a cryſtalline form, but the Cryſtals prove extremely different, in taſte as well as in their other qualities, from thoſe of Alum: the Aluminous Earth is a ſubſtance of a peculiar kind, hitherto nowhere diſcovered but in the Alum itſelf, (See Alum) Solution of Chalk in the nitrous Acid forms, on evaporation, a tenacious maſs like Turpentine; which exſiccated, and calcined a little, proves luminous in the dark. This Phoſphorus is uſually diſtinguiſhed by the name of its firſt diſcoverer, Balduin: it is called alſo *Phoſphorus Hermeticus*, from its being kept in hermetically ſealed glaſſes to ſecure it from the air. It differs from ſome other Phoſphori, in appearing in ſome degree luminous, after expoſure to the light of a taper as well as of the ſun. CHALK.

Chalk is precipitated, from its ſolutions in both the mineral Acids, by volatile and by fixt Alcalies, into a white Powder; provided the Solutions are conſiderably diluted with Water. When the undiluted Solutions are mixed with ſaturated Alcaline Liquors, inſtead of a precipitation, the mixtures coagulate, and become ſo thick, that the glaſs may be turned upſide down without ſhedding its contents. Coagulation.

Pure Chalk melts eaſily with Alcali and Flint into a tranſparent colourleſs Glaſs (*m*). Calcined, by a ſtrong fire into Quick-lime, it loſes much of its diſpoſition to vitrify: It is now found to melt very difficultly and imperfectly, and Vitrification of Chalk.

(*m*) *Vitrification of Chalk.*] Chalk vitrifies with Alcaline Salt ſomewhat more difficultly, and with Borax ſomewhat more eaſily, than Flint or Sand: it requires about equal its own weight of the Alcali; of Borax, half its weight is ſufficient: the glaſſes made with both, particularly thoſe with Borax, are commonly of a fine pale green or yellow colour. Sal Mirabile and Sandiver, which do not vitrify at all with the cryſtalline Earths, form, with half their weight of Chalk, the firſt a yellowiſh black, the latter a greeniſh Glaſs. Nitre, on the other hand, one of the moſt active fluxes for Flint, does not perfectly vitrify with Chalk.

Vitrification of Calcareous with other Earths.] Chalk notably promotes the vitrification of Flint; a mixture of the two requiring leſs Alcali than either of them ſeparately. If Glaſs made from Flint and Alcali be ſaturated with the Flint, ſo as to be incapable of bearing any further addition of that Earth, without becoming opake and milky; it will ſtill, in a ſtrong fire, take up a conſiderable proportion, one fourth or one third its weight, of Chalk, without injury to its tranſparency. Hence Chalk is ſometimes employed in compoſitions for Glaſs, as a part of the Salt may then be ſpared.

Mixtures of Chalk with pure white Clay melt without any addition: they are difficultly brought to perfect tranſparency in veſſels; but if expoſed to the immediate action of the fire, in contact with the burning fuel, they vitrify with eaſe. I have made covers for crucibles of ſuch a compoſition, and unexpectedly found them melt, in no very vehement heat, into a hard, tranſparent, yellow Glaſs; they often melted and dropt down into the crucible before the vitreous compoſitions included in it had begun to run. The addition of Flint or Sand promotes the vitrification.

Mr. Pott has given ſome intereſting experiments of the effects of Chalk on the ſtony matters intermixed among or inveſting metallick Ores. Some of theſe Stones are ſo hard as to ſtrike fire with Steel, and either pellucid and colourleſs, or leſs tranſparent and ſomewhat milky. Others are ſo ſoft as to be cut with a knife, remarkably heavy, when pure of a milky whiteneſs inclining a little to yellow, generally of a leafy or ſhivery texture, ſometimes tinged with red, green, and other colours reſembling thoſe of the Gems, whence the names *Pſeudo-hyacinthus*, *Pſeudo-ſmaragdus*, &c. Of theſe ſofter

CHALK. and render the Glaſs milky. In either ſtate, it does not vitrify of itſelf in the moſt intenſe fires; and is ſuppoſed in ſome meaſure to reſiſt the action of Glaſs of Lead, Luna Cornea, and ſome other ſubſtances, which ſoon corrode and penetrate the common earthen veſſels: hence ſome have been accuſtomed, for detaining thoſe bodies in fuſion, to line the crucible with Chalk made into a paſte with Solution of Borax.

Chalk with Antimony. Chalk added to Antimony in fuſion is ſaid to abſorb the ſulphureous part of that Mineral, and precipitate the Reguline or Metallic to the bottom. On trial this experiment did not ſucceed: two ounces of powdered Chalk being ſtirred, with a clean tobacco-pipe, into four ounces of melted Antimony; and three ounces of Chalk mixed in the ſame manner with five ounces of Antimony; there was no ſeparation, in either caſe, of any Regulus; the whole remaining equally mixed. That the Chalk had nevertheleſs acted upon the Sulphur, appeared upon boiling a little of the maſs in water: the liquor became tinged, as from Sulphur combined with Alcalies, and on the addition of Vinegar, depoſited a Precipitate reſembling the golden Sulphur of Antimony.

Silver produced. Henckel, in his Pyritologia, relates a remarkable experiment of a granule of Silver being obtained by barely roaſting the common ſulphureous Pyritæ with Chalk; though neither one or the other, examined ſeparately with different additions, diſcover any footſtep of that metal. I have treated Chalk with various inflammable ſubſtances, without being able to obſerve the leaſt mark of any thing metallic. With ſimple inflammable matters, as Tallow, Pitch, Wax, powdered Charcoal; the Chalk remained a white, remarkably ſpongy, light, crumbly maſs, notably diminiſhed in weight: from two ounces of Chalk and one ounce of Charcoal, no more than an ounce was left; all the reſt being volatilized (*n*). With fixt Alcalies on the other hand, it melted into a compact vitreous maſs, whoſe deficiency in weight was only half an ounce upon two ounces of Chalk and one ounce of the Alcali.

Chalk treated with inflammable ſubſtances.

It

ſofter Stones there are two different kinds, ſcarce to be diſtinguiſhed by the eye, but eaſily by a little Aqua fortis, which effervesces with and diſſolves one ſort, but has no action on the other.——The ſoluble ſoft Stones, and the pellucid hard ones, are little affected by Chalk: the indiſſoluble ſoft, and the milky hard ones, though entirely unfuſible of themſelves, melted readily with this Earth, flowed thin as water, and when the fire was kept up for ſome time, run clean through the crucible. Whether the Chalk or the Stone prevailed in the compoſitions, whether four parts of the Chalk were taken to one of the Stone, or four parts of the Stone to one of Chalk, the ſame ſurprizing fuſibility was always obſerved. Theſe mixtures brought Earths of all the other claſſes alſo into fuſion along with them; and when ſaturated with theſe, were leſs apt to corrode the veſſel. Different calcareous bodies, as Chalk, Limeſtone, Marble, had the ſame effects: but the mineral Stones differed a little in point of fuſibility, the ſoft being more fuſible than the hard—Theſe experiments may probably be applicable to valuable purpoſes in the running down of Ores.

(*n*) *Chalk volatilized.*] All the calcareous Earths and Stones loſe a large proportion of their weight on being urged with a ſtrong fire without any addition: The harder the Stone, the leſs is the diſſipation. Chalk loſes near two-thirds of its weight in being burnt into Quick-lime; the harder calcareous Stones, as Marble, about half their weight.

It has been ſaid, that Sope diſtilled with Chalk turns all to water: but on trial, this did not ſucceed. Chalk, which as we have already ſeen unites eaſily with Alcalies in the fire, abſorbs the Alcaline Salt of the Sope; upon which the water of the Sope diſtils, along with its Oil, now rendered empyreumatic by the heat. If the diſtilled liquor be repeatedly drawn over from freſh parcels of Chalk, leſs and leſs Oil will be obtained in every diſtillation, till all the Oil is, as all Oils are by the ſame treatment, deſtroyed. CHALK. With Sope.

Chalk mixed with Sal Ammoniac, extricates no urinous ſmell: but if the mixture be expoſed to the fire, the Chalk will then act upon the Salt, abſorb its Acid, and diſengage its Volatile Alcali, which is thus obtained in its proper concrete form. See Sal Ammoniac. With Sal Ammoniac.

Chalk is employed, in medicine, againſt the heart-burn, and other complaints ariſing from acidities in the firſt paſſages; and ſometimes as a deſiccative for running ſores and ulcers. It is the baſis of the cardialgic troches of the ſhops; to which ſome prefer Chalk itſelf in powder; the Sugar, which enters in large quantity in the troches, being often found to aggravate thoſe complaints. Chalk is more ſtyptic than moſt of the other abſorbent Earths, and therefore to be uſed with caution. Some have taken it freely, for procuring a white complexion; but its more certain effects are gripes and obſtructions. It is ſometimes employed for curing Wines or Malt Liquors on the fret: it takes off their acidity, but renders them very apt to grow vapid. Medicinal uſes.

In the Chalk-pits are found black or blackiſh brown ſemitranſparent Stones, ſo hard as to ſtrike fire with Steel. Many of theſe appear externally whitiſh and corroded as it were; and on being broke, prove gradually more compact, and darker coloured, from the ſurface to the center; as if the Chalk was produced from a corroſion and reſolution of the Stone by mineral vapours. On this preſumption, ſundry trials were made for obtaining a like reſolution by art. The Stones were calcined by the greateſt heat procurable in a potter's furnace; but they remained as compact and ſolid as at firſt, and what is remarkable, loſt nothing of their weight. Calcination in mixture with Pit-coal ſucceeded no better: nor did expoſure to the fumes of Pit-coal, or of Sulphur, make any change in the Stone. The pulveriſed Stone, mixed with Sulphur, and calcined, ſuffered no diminution, nor any other alteration than becoming darker coloured. The Powder, both calcined and uncalcined, was examined alſo with Acids; but none of them had any action on it, except that Oil of Vitriol acquired from the crude Stone a red tinge; which that Acid readily does from any thing impregnated, however ſlightly, with inflammable matter. Theſe Stones appear therefore to be of a different nature from Chalk, and to belong to another claſs [the Cryſtalline]. Stones in Chalk-pits.

II. OSTEOCOLLA.

OSTEOCOLLA is a foſſil ſubſtance, found in ſandy grounds, in ſeveral parts of Germany; ſpreading from near the ſurface, to the depth of four, ſix, ten and more feet, like the roots of a tree; ſome of the ramifications are as large as a child's arm; others, no thicker than a quill. Whilſt under the earth, OSTEOCOL. Deſcription.

OSTEOCOL. earth, it is ſoft, almoſt like ſlaked Lime tempered with Sand, ſo as ſcarce to be got up entire: in colour it is ſometimes yelloviſh or browniſh, but moſt commonly greyiſh or whitiſh. Dried, it becomes whiter and harder, and ſometimes exhibits reddiſh or yelloviſh ſpecks or veins. Moſt of the pieces are internally hollow: ſome have a core of a corrupted woody matter.

Hiſtory. The origin of this concrete has been greatly controverted, and greatly miſunderſtood. Moſt of the ancients imagined it to be petrified Bones, though it has no reſemblance in figure to any kind of Bone: ſome have ſuppoſed it a truly mineral ſubſtance, proceeding from the finer parts of the Sand, among which it is always found, conglutinated together by ſubterraneous vapours; whence it has been named *Lapis Sabuloſus*. Ferrantus Imperatus, in his *Iſtoria Naturale* firſt publiſhed in 1599, gives a copper-plate of three pieces of Oſteocolla, under this title: "Oſteocolla is a petrified root, compoſed of a ſoft "cement and a ſandy ſubſtance, employed by the German phyſicians for "conſolidating broken bones." That this is its true original, I have been convinced from ocular obſervation: After many fruitleſs ſearches, I found at laſt, near the village of Tſchernow or Tſcharno, the remains of the trunck of a tree with a living branch upon it, and its roots changed wholly into Oſteocolla. The tree was the common black poplar, *Populus nigra*, *C. B.* (*o*).

A petrified root,

examined by Acids, &c. Diluted Spirit of Vitriol poured upon Oſteocolla, totally diſſolved it, with conſiderable efferveſcence: ſome cryſtalline concretions ſeparated from the liquor, but on adding more of the Acid they were taken up again: the Solution being inſpiſſated, the dry maſs was found to weigh one ſixth more than the Oſteocolla at firſt. The concentrated vitriolic Acid, on the other hand, diſſolved

(*o*) *Natural Hiſtory of Oſteocolla.*] The author's account of this curious foſſil is confirmed by the obſervations of Mr. Gleditſch, who in the Berlin memoirs for the year 1748, has given a particular deſcription of it as met with in the marquiſate of Brandenburg. It is dug among Sands, which are ſaid to have been once covered with foreſts, where ſome Pines and Birches ſtill remain, and where he found a living Pine with part of its root changed into Oſteocolla. The Oſteocolla is externally full of knobs, and often has a cavity running along one ſide: no mark is left of the Bark or woody circles, but ſometimes, though rarely, the Parenchyma is found at the extremity of the root: no ſmall fibres are ſeen, but there are protuberances and cavities, which plainly diſtinguiſh the places where they iſſued from: ſome pieces, eſpecially the larger ones, are encloſed in a particular kind of ſubſtance, not very compact, conſiſting manifeſtly of the mouldered Bark and rotten woody parts. Some large branches diſcover, on breaking, the remains of the petrified wood; others have a hard woody core almoſt like Horn, extending ſometimes to the length of five or ſix feet. The ſubſtance of the Oſteocolla is internally ſoft and of a looſe texture; externally harder and ſandy, ſometimes, eſpecially in the ſmall branches, ſo hard as to ſtrike fire with Steel.

The Sands in which the Oſteocolla is met with, have an admixture of a fine white calcareous Earth, which ſticks to the fingers, looks like meal, and when waſhed down from the higher grounds by rains and collected in cavities, appears in form of an emulſion. The Sand adjoining to the Oſteocolla abounds moſt with this Earth; and the foſſil itſelf appears to be compoſed of the ſame Earth mixed with the Sand. If powdered Oſteocolla be agitated with water, the calcareous Earth remains for a time ſuſpended, ſo as to be poured off with the liquor, whilſt the Sand is left behind. The Sand and Earth are nearly in equal proportions.

diſſolved only eight grains out of ſixty; though more and more of the Acid was added to the Powder, ſo long as it occaſioned any effervescence: the colour of the Solution was a Gold yellow. Spirit of Nitre, Spirit of Sea-Salt, and Aqua Regis, diſſolved each twenty-four or twenty-five grains out of ſixty; nor would a freſh addition of either of theſe Acids take up any more: Aqua Regis ſeemed to act the moſt difficultly of the three, and when added in an over-proportion, after the Solution had been ſaturated, precipitated a part of what had been before diſſolved. Diſtilled Vinegar took up but ten grains, or one ſixth of the Oſteocolla. OSTEOCOL.

Diſtilled Water, long boiled with an ounce of Oſteocolla, appeared, after repeated filtrations, turbid and milky. On ſtanding for a length of time, it depoſited a ſcruple of an extremely fine Powder, and became clear: the liquor, being now examined by Alcalies, Acids, and Syrup of Violets, gave no marks of its having received any Saline impregnation from the Oſteocolla. Alcaline Lixivia boiled with this Concrete, appeared upon moſt trials to be ſtill merely Alcaline; but on adding to the inſpiſſated liquor ſome Oil of Vitriol, vapours aroſe like thoſe of Spirit of Sea-Salt, and on ſtanding for a length of time, a little ſlippery curdly matter ſeparated.

Forty-eight ounces of freſh Oſteocolla, diſtilled in a glaſs retort, gave firſt eight ounces of an almoſt inſipid and inodorous phlegm; then three ounces of a bituminous liquor, and at laſt one ounce of a ſtronger ſpirit, which ſmelt conſiderably of Petroleum, effervesced with Oil of Vitriol, and changed Syrup of Violets green. Freſh ſoft Oſteocolla, diſtilled with Oil of Vitriol, in a tubulated retort, yielded an Acid Spirit, the ſame with that of Sea-Salt: by ſaturating the Spirit with Salt of Tartar, I obtained a true regenerated Sea-Salt; and by diſtilling this Salt again with Oil of Vitriol, a concentrated Spirit of Salt. Freſh Oſteocolla, which had been boiled in Water, ſtill yielded with the Vitriolic Acid a Marine Spirit. By diſtillation.

Oſteocolla calcined in an open fire, loſt in weight four ſcruples upon half an ounce, and became ſomewhat duller in colour: Water boiled on the calx, made no effervescence on the admixture of Alcalies, and depoſited no Precipitate; but Oil of Vitriol mixed with it extricated vapours of Marine Acid. Equal parts of powdered Oſteocolla and fixt Alcaline Salt, urged in a crucible with a ſtrong fire, melted into an untranſparent vitreous matter, moderately hard, and of a grey colour: Water extracted from this maſs a part of the Alcali, as appeared from the liquor changing Syrup of Violets green (*p*). By calcination and vitrification.

LIME-

(*p*) *Chemical hiſtory of Oſteocolla.*] Mr. Margraff, in the memoirs above-mentioned, has given a more particular examination of this Concrete. Eight ounces of one of the pureſt pieces (taken from a Pine-tree) were ſeparated, by waſhing over with water, into four ounces and a half of white Earth, and three and a half of Sand—— The Earth effervesced with Acids, and formed with them the ſame compounds as Chalk or Limeſtone: Uniting with the Vitriolic into a thick ſubſtance like pap, which diluted with water yielded on evaporation a few ſmall oblong Cryſtals: almoſt totally diſſolving in the nitrous and marine, refuſing to cryſtallize with either, when exſiccated by fire deliquiating again in the air; yielding with the nitrous a Phoſphorus, the ſame with that of Balduin formerly mentioned. Calcined, it became a true Quicklime, not differing on any trial from the common Limes——The Sand of Oſteocolla,

III. LIME-STONE.

L. STONE. Natural History.

LIME-STONE is a general name for all the Stones from which Quick-lime is commonly prepared. Of theſe there are a great variety: ſome are pale coloured, grey, whitiſh, or yellowiſh; others darker, browniſh or reddiſh: ſome are of a ſpongy, ſcaly, or ſhivery texture; others, cloſe and compact: ſome entirely opake, others ſemitranſparent. They are of all degrees of hardneſs, from Chalk up to Marble; which laſt is the hardeſt of the Stones that are convertible into Lime. The ſofter kinds are generally made choice of for burning: and the harder employed as building-ſtones or for other uſes: the Lime uſed about London is made chiefly from Chalk. Sea-ſhells likewiſe afford a good Lime, and in ſome maritime places ſupply the want of the proper mineral Stones.

Contains Acid, &c.

All Lime-ſtones contain a portion of ſulphureous matter, as is evident from the ſtrong ſmell which ariſes in burning them, and which extends to a conſiderable diſtance from the kilns. The Lime-ſtones uſed in this country yielded in diſtillation an Acid Liquor, which turned Syrup of Violets red, precipitated Solution of Silver, and formed with Mercury a corroſive Sublimate; a proof that the Acid was marine. The ſame Acid was diſcovered alſo after the Stone had been burnt into perfect Lime; Oil of Vitriol extricating from the Calx vapours manifeſtly marine. The Limes prepared from different Stones, though they may anſwer equally for morter and other common uſes, are found to differ conſiderably in ſome of the nicer chemical experiments.

IV. QUICK-LIME.

Q. LIME. General properties.

QUICK-LIME is an acrid Calx, ſo corroſive as to be employed by the tanners for deſtroying the fat and fleſhy parts of ſkins, and occaſioning the hair to ſeparate. It raiſes a ſtrong heat and ebullition on the affuſion of water, and in part diſſolves; rectified Spirit of Wine has ſcarcely any action on it, and oils none at all. Slaked with water, or moiſtened into the conſiſtence of a paſte, and mixed with a proper quantity of Sand or other hard bodies, it acquires a notable degree of hardneſs on expoſure to the air; hence morter and cements (*q*): A large quantity of water impairs or deſtroys this property.

colla, melted with an equal quantity of fixt Alcaline Salt, yielded a Glaſs of a fine yellow colour, probably from ſome admixture of ferrugineous matter: the calcareous Earth, like common Lime, formed with twice its weight of the Salt only an opake whitiſh maſs.——Eight ounces of Oſteocolla entire, diſtilled in an earthen retort by a ſtrong fire, gave two drams of an empyreumatic volatile Alcaline Spirit: in diſtillation with Oil of Vitriol, no other than mere phlegm was obtained.

(*q*) *Morter and Cements.*] Lime made into a paſte with water alone, acquires on expoſure to the air ſome degree of hardneſs, which ſeems to be proportionable to that of the original Earth or Stone which the Lime was made from; the Chalk Limes remaining ſoft and crumbly, whilſt thoſe prepared from Marble become notably hard. If either of them be mixed with glutinous liquors, as Milk, Blood, Solution of Gum, or beat with Cheeſe ſoftened by boiling in Water, they become harder than by themſelves,

property. The vapour which ariſes during the extinction, collected by diſtil- Q. LIME.
lation, proves a liquor of a very ſingular kind. It changes Syrup of Violets green, and being mixed with Solution of Sublimate throws down an orange yellow Precipitate; as if the diſtilled Spirit was not only alcaline, but a fixed Alcali: it precipitated alſo Solution of Sulphur made in Alcalies, as if it was an Acid. In ſlaking a pound and a half of Quick-lime, an ounce of this liquor was collected. Singular Spirit in its extinction.

The quantity of Lime diſſoluble in water is much greater than is generally ſuppoſed. In the common method of making Lime-water, with only a ſmall proportion of liquor, the Lime loſes little; but if the reſiduum be repeatedly boiled in large quantities of freſh water, almoſt half the Lime will at length be diſſolved (*r*). Quantity diſſoluble in water.

Lime-water turns Syrup of Violets green; added to Solution of Sublimate (*s*), throws down a yellow Precipitate; unites with Oils into a ſemiſaponaceous maſs; diſſolves Sulphur into a red Liquor. In theſe properties it agrees with fixt Alcaline Lixivia; there are others in which it as remarkably differs from them. Alcalies mixed with Lime-water, precipitate the Lime from it: on expoſure to the air, the Lime ſeparates ſpontaneouſly, ariſing in cruſts to the ſurface: in cloſe veſſels this ſeparation does not happen. Though the Lime in ſubſtance ſuſtains the moſt intenſe fires without diminution of its weight; the part which diſſolves in water, is, upon boiling the liquor, totally diſſipated. Agreement of Lime-water with Alcalies; and diſagreement. Volatilized.

ſelves, and in a ſhorter time: hence the uſe of theſe compoſitions for joining cracked Glaſſes, *&c.* Lime mixed with Sand, or other hard ſtony bodies in coarſe Powder, forms a concrete ſtill harder, and whoſe hardneſs is increaſed by length of time; whence in part the remarkable induration of the morter of ancient buildings. With Sand or Flint in fine Powder, it did not ſeem to grow harder than by itſelf: nor did any of the Earths of the other claſſes ſenſibly improve its conſiſtence.

(*r*) *Lime with Water.*] This property of Quick-lime, of impregnating a very large quantity of Water, has been remarked alſo by Dr. Alſton, and confirmed by a number of experiments, in a Diſſertation upon Quick-lime. He finds that about one third of the Lime diſſolves; and that this requires for its Solution ſeveral hundred times its own weight of Water.

If the indiſſoluble part be calcined afreſh, it impregnates Water in the ſame manner as at firſt; and by repetitions of the calcination, may at length be almoſt wholly diſſolved. On expoſure to the air, the Lime ſeparates from the Water, and proves inſipid like the crude Earth or Stone: by a freſh calcination it becomes Quick-lime again.

Quick-lime expoſed to the air, unmoiſtened, falls by degrees into Powder, and loſes its activity: if kept moiſtened with Water, it in great meaſure retains its acrimony, and its peculiar qualities, for years.

(*s*) *Lime-water precipitates Mercury Sublimate.*] It has been preſumed that Lime-water would precipitate all the Metals, but experiment ſhews the contrary. Dr. Brandt obſerves, in the Swediſh Tranſactions for the year 1749, that neither Gold, Silver, Tin, or Copper are precipitated by it; that Iron is not precipitated at all from the nitrous or marine Acids, and but imperfectly from the Vitriolic; that Quickſilver diſſolved in Aqua fortis, falls in part upon the addition of the calcareous liquor, but that a part ſtill remains ſuſpended, precipitable by an Alcaline one. He found that even Quick-lime in ſubſtance did not totally precipitate metallic bodies: A quantity of freſh burnt Quick-lime having been added to a Solution of Silver, and the liquor after due digeſtion poured off clear and paſſed through a filter, common and Alcaline Salts ſtill threw down a Precipitate, which yielded on reduction near one ſixth of the original quantity of Silver diſſolved.

Q. LIME. dissipated in the air along with the watery vapour. Solution of Sulphur made by Quick-lime, on being kept for a length of time in a warm room, yields Crystalline Concretions, of the Selenitic kind, not dissoluble in water (*t*).

Artificial Selenites.

Volatile Spirit of Sal Ammoniac with Quick-lime.

Quick-lime, mixed with Sal Ammoniac, immediately disengages its volatile Alcali, without the application of any heat. But it produces at the same time a remarkable change in the Alcali itself; which, when extricated by Quick-lime, never assumes a solid form, but proves an extremely subtile Volatile Spirit, much stronger and more penetrating in smell, and for sundry bodies a more powerful menstruum, than that prepared with fixt Alcaline Salts: the Spirit made with Quick-lime does not coagulate, like the other, with rectified Spirit of Wine, and hence is preferable as an ingredient in those compositions where Alcaline and vinous Spirits are mixed; nor does it effervesce considerably with Acids, though it precipitates most metallic solutions made in them.

A concrete. Salt obtained from it.

Though the volatile Alcali is in this spirit highly attenuated and subtilized into a fluid state; it is still recoverable again in its proper solid form. If the spirit be saturated with the Acid of Sea-Salt, the liquor duly evaporated and set to shoot, Crystals of true Sal Ammoniac will be obtained: and if from these we extricate the volatile Alcali by means of Chalk or of fixt Alcalies, it will now concrete into a solid mass. During the saturation of the spirit with the marine Acid, a strong fetid smell arises.

Volatile Salts destroyed by Lime.

Zwelfer relates, and Stahl has borrowed the observation from him, that volatile Salts are totally destructible by Quick-lime. I have made sundry trials for determining this point; and found, that with Quick-lime in substance, the destruction scarcely succeeds: for some Spirit of Sal Ammoniac having been distilled no less than twenty times from unslaked Lime, a volatile spirit was obtained to the last. By Lime-water on the other hand, the volatile Alcali was quickly destroyed: a dram of pure Volatile Salt being added to two quarts of Lime-water, much, but not all, of the volatility was lost, and great part of the Earth of the Lime was precipitated: the mixture being digested, committed to distillation, and all the volatile part drawn off; the distilled spirit, mixed with fresh Lime-water, occasioned no further precipitation, and no longer discovered any degree of volatility.

Some

(*t*) *Lime with Acids.*] The Selenitic Crystals, here obtained, were produced from the Lime combined with the Acid of the Sulphur: See p. 8.——The sulphureous or vitriolic Acid, poured upon Quick-lime in substance, unites with it far more readily than with the Lime-stone or Chalk: it dissolves very little of the crude Earth or Stone, and scarcely loses any of its acidity: whilst by Quick-lime, if the due proportion is hit, the whole of the Acid is instantly absorbed, and the liquor left insipid: The concretes, which the Earth in both states forms with the Acid, are the same, a kind of Gypsum or Selenites——The other Acids perfectly dissolve Quick-lime, as they do the crude Earth, but without effervescence. The Solution made in the marine Acid coagulates with Alcaline Lixivia, and with the Vitriolic Acid; changes the colour of Syrup of Violets to a green, and hence has been mistaken for an Alcali; and unites with expressed Oils into a butyraceous substance: inspissated, it yields an highly penetrating saline mass, which deliquiates in the air, dissolves in rectified Spirit of Wine, flows in a small heat, and does not part with its Acid in a strong one: if the matter be incrustated on iron-rods and struck upon, it sparkles and appears luminous through the whole extent of the stroke.

Some have pretended to extract a Salt from Lime, that ſhould diſſolve the human Calculus. Dr. Cyprianus, in London, worked on this ſubject for ſix years; and I proſecuted the inquiry under his inſpection, for three years longer; purſuing all the hints of Helmont, Paracelſus, and others, but without ſucceſs. Moſt of the cryſtalline concretes obtained from Lime, are rather earthy, ſtony, and ſelenitic, than ſaline: And when we gain any thing that is truly ſaline and ſoluble in water, a further examination diſcovers that it is chiefly adventitious, and has rarely any thing of the Lime in it. Two papers on the Salt of Lime, by Mr. du Fay, may be ſeen in the French memoirs for the years 1724 and 1732 (*u*). Dr. Pott has given ſome curious experiments on the ſolution of Lime in Spirit of Nitre, in the *Miſcellanea Berolinenſia* (*x*). Q. LIME. Salt of Lime.

Quick-lime is employed for many conſiderable uſes in chemiſtry and the chemical arts; as in the rectification of Malt-Spirits, empyreumatic Oils, and volatile Salts, from its property of imbibing and detaining groſs Oils; in the ſmelting of ſulphureous and arſenical Ores (*y*), from its abſorbing thoſe volatile Uſes of Lime.

(*u*) *Salt of Lime.*] On evaporating Lime-water, a ſmall portion of ſaline matter commonly remains: This has been ſuppoſed an eſſential part of the Lime; the principle on which its activity as a menſtruum depends. But experiments have ſhewn, that this ſubſtance has nothing of the diſſolving power of Lime-water: That it is different in different Limes, being ſometimes vitriolic and ſometimes marine: And that the ſtrong and pure Lime-water, made from Lime once elixated and calcined again, leaves no ſaline matter at all.

(*x*) *Experiments on Lime and Spirit of Nitre.*] The more remarkable of theſe experiments are as follows.——Concentrated Spirit of Nitre, poured upon heated Quick-lime, diſſolved it into a blood-red liquor; which mixed with half its quantity of the phlegm of Spirit of Nitre, yielded in diſtillation an acidulous oily phlegm, condenſing like Spirit of Wine into Striæ; ſucceeded by a ſimilar ſtriated Spirit, ſomewhat more acid, in white fumes. The remainder, now of the conſiſtence of Honey, being further urged, gave over a highly corroſive Acid, in red vapours. The Caput Mortuum was auſtere, bitteriſh, and ſomewhat ſtyptic; and could not be made to appear luminous in the dark, as Chalk does when treated in the ſame manner.

The oily phlegm, boiled on freſh parcels of the Honey-like maſs till it had loſt both its oilyneſs and acidity, yielded on evaporation an elegant Salt, of a bitteriſh, nitrous, not diſagreeable taſte, which taken in a gouty caſe procured a gentle diaphoreſis, and a copious diſcharge by urine. The corroſive red ſpirit being poured to this Salt, and the liquor evaporated, a fine Nitre was obtained, which deflagrated more quickly than common Nitre.

The ſpirit became ſtronger and more corroſive by repeated cohobations on the Caput Mortuum. At the third cohobation, it appeared of an oily nature, and proved oily to the touch: the red fumes, tranſpiring through a crack in the luting, took fire from a candle. Some fine Silver having been diſſolved in the cohobated ſpirit, the liquor diſtilled off, and the dry matter kept melted for ſome time; the maſs when cold, looked blue: the diſtilled liquor being cohobated on this maſs, and drawn off again, the dry remainder appeared tinged throughout of a beautiful, deep ultramarine blue: on a third cohobation, the matter grew whitiſh, and at every ſucceeding one whiter and whiter, till at length no blueneſs remained——The ſpirit, ſet in digeſtion without addition, lets fall a notable quantity of a dark brown unfuſible Powder; which is probably a part of the Lime that had been volatilized by the Acid. Mr. du Hamel obſerves, that Quick-lime is by this Acid almoſt totally volatilized, ariſing with it in diſtillation in a liquid form.

(*y*) *Quicklime in the ſmelting of ſulphureous Ores.*] It is commonly ſuppoſed that Quick-lime

Q. LIME. volatile ſubſtances, which would diſſipate a part of the metal; in the making of Sope, for increaſing the activity of Alcaline Salts; in dying, particularly with Indigo, *&c.*

CLASS III. GYPSEOUS EARTHS *and* STONES.

Earths or ſoft Stones,—reducible by a moderate fire into an inſipid Calx, which forms with water a tenacious Paſte, and which by ſtronger calcination loſes that property;—in their natural ſtate not acted upon by any Acid;—becoming ſoluble in Acids, and ſimilar to Quick-lime, by calcination in contact with the fuel.

I. LAPIS SPECULARIS.

SPECUL. THE *Lapis Specularis* or *Glacies Mariæ* is a tranſparent concrete, commonly found in pretty large maſſes, which may be eaſily ſplit into a number of thin plates or leaves, ſometimes ſo broad as to be uſed for lanterns. Its foliaceous texture has occaſioned it to be often confounded with Talc (z); from which it may be readily diſtinguiſhed, by the tranſparency of the entire maſs as well as of the ſingle leaves; by its glaſſy rather than unctuous ſmoothneſs, and rather a vitreous brightneſs than a ſilver hue; by the maſs being eaſily pulverable, and eaſily calcinable in the fire.

II. SE-

lime abſorbs Sulphur from all the metals; and hence ſome have preſumed that the addition of Quick-lime to ſulphureous Ores would ſupply the place of calcination. This does not appear however to obtain. When Copper is blended with Sulphur and a little Iron, as in moſt of the rich Copper Ores; Quick-lime abſorbs and vitrifies with the Iron, leaving the Copper ſulphurated as at firſt. Sulphurated Iron that holds no Copper, melts with Lime into one uniform maſs, without any ſeparation at all: and when a large quantity of Iron is blended with Sulphur and Copper, the effect is the ſame; Quick-lime uniting equally with all the three. Dr. Brandt obſerves that both Copper and Iron Ores, thoroughly calcined, melt eaſily with Quicklime into Glaſs; probably from the action of the calcareous Earth on the ſtony matter of the Ore, (ſee page 10.) for with pure calces of thoſe metals it refuſes to melt. Quick-lime is in general much more difficult of fuſion, both with earthy and ſaline bodies, than the calcareous Earth or Stone in its natural ſtate.

(z) *Confounded with Talc.*] The Powder which Mr. Reaumur received from China under the name of *Petuntſe* as one of the ingredients in the Chineſe ware, and which, from ſome flaky or ſtrawy particles obſerved in it, he calls Talc, appears to have been an Earth of this kind; ſome of our Gypſums exhibiting a like ſtrawy texture, whence they are diſtinguiſhed by the name of *Gypſum Striatum.* He ſays this Chineſe Talc baked with Flints into a ſubſtance reſembling Porcelane; and that Talcs found in France did the ſame; a property belonging to all the gypſeous Earths, but to none of the true Talcs——The other ingredient in China-ware, called by the Chineſe *Kaolin*, is ſaid by the ſame author to be a ſpecies of Flint; but from its forming with water a maſs tenacious enough to be made into the loaves in which it was brought over, it ſhould ſeem rather to be of the argillaceous kind.

Theſe ſuſpicions are confirmed by ſome experiments of Mr. Scheffer's (in the Swediſh Tranſactions for the year 1753) upon a ſpecimen of Petuntſe obtained from China. It was a glittering, ſemitranſparent, flaky maſs, like the *Lapis Specularis*, of a light greeniſh

II. SELENITES.

THE Selenites reſembles in appearance ſometimes the Lapis Specularis, and ſometimes Cryſtal; but wants the leafy ſtructure of the one, as well as the hardneſs of the other. It is found both in large and in ſmall maſſes, always tranſparent, but not always free from cloudineſs; and ſometimes of a yellowiſh tinge. It eaſily calcines into Gypſum or Plaſter-of-Paris (*a*). A portion of ſelenitic matter is contained in ſundry waters, as thoſe of Pyrmont, and ſeveral of the mineral waters of France, as appears from the analyſes of them related in the memoirs of the French academy. SELENIT.

III. BOLOGNIAN STONE.

THIS Stone has become remarkable from its property of affording a Phoſphorus by calcination, firſt diſcovered by a ſhoemaker, Vincenzo Caſciarolo (*b*). The Stone is found in the hill called Monte di Paderno about three BOLOGN.

greeniſh grey colour, and remarkably heavy. It was not acted upon by Acids: in the fire, it burſt and fell in pieces, and calcined into a white Powder, interſperſed with a red ferrugineous matter. Calcined in contact with the fuel, it emitted ſtrong ſulphureous vapours like the other Gypſa, and became quite white, conſiderably firm and coherent, and ſemitranſparent. A mixture of the powdered Stone with tobacco-pipe Clay yielded a Porcelane not fully ſo white as the Chineſe: This imperfection he attributes to the Clay, which when burnt hard, is never of ſuch whiteneſs as the leſs burnt tobacco-pipes.

(*a*) *Calcines into Plaſter-of-Paris.*] The Stones from which Plaſter-of-Paris is uſually prepared, are of a granulated ſtructure and ſemitranſparent; ſometimes compact and moderately hard, ſometimes lax and crumbly. The calcination is performed with a heat ſomewhat below ignition: the Stone ſeems as it were to liquefy and to boil, emits aqueous vapours, and at length ſubſides into a ſoft Powder; the mark of the calcination being completed. The Powder, made into a Paſte with water, becomes quickly a conſiſtent maſs, of no great hardneſs, but ſonorous, and of a ſmooth ſurface: hence its uſe as cement, and for taking off impreſſions. The matter expands in becoming ſolid, receives no increaſe but rather a diminution of its hardneſs on expoſure to the air, readily imbibes water, but is not acted on by any Acid. The further the Earth has been calcined, the Paſte hardens the more ſlowly, and proves the leſs tenacious, but more durable. Kunckel gives ſeveral receipts for tinging Plaſter of a variety of colours, by uſing, inſtead of plain water, coloured decoctions, as of red Saunders, Brazil-wood, Saffron, *&c.* and ſays the hardneſs may be improved by diſſolving a little Gum, or rather Iſinglaſs, in the liquor.

The gypſeous Earths calcined by a ſtrong fire, in immediate contact with the burning fuel, emit ſulphureous vapours, and become Quick-lime. The principle they have loſt in this operation is the vitriolic Acid; of which it is a diſtinguiſhing character, to form Sulphur with inflammable matters. The calcined Earth, combined afreſh with that Acid, regenerates Gypſum again: and the common Quick-limes, or unburnt calcareous Earths, yield with the ſame Acid the ſame compound.

(*b*) *Bolognian Stone.*] Mr. Margraf firſt obſerved that this property is common to the other Gypſums when pure from metallic or other heterogeneous admixtures; and that the artificial Gypſums ſucceed equally with the natural. For preparing this Phoſphorus in perfection he directs the Stone to be

BOLOGN. three miles from Bologna; as alſo on the Piedalbino at the foot of the Alps, about eight miles from the ſame city. It is met with chiefly after heavy rains; by which the looſe Earth is waſhed off, and the Stone left bare. It is of various figures and ſizes: ſome maſſes weigh no leſs than eight pounds; but thoſe of an ounce or two anſwer beſt for making the Phoſphorus.

Phoſphorus. The Phoſphorus is thus prepared. Some of the fineſt Stones are reduced into a ſubtile Powder in a braſs mortar; and entire Stones, well cleaned or filed on the ſurface, and moiſtened with Spirit of Wine, are rolled in this Powder, and the proceſs ſeveral times repeated, till they are all over coated with the Powder; after which, the Stones are calcined among burning Charcoal in a moderate wind-furnace. When grown cold, they are commonly cleared from the powdery cruſt, and wrapt up in Cotton. The principal cautions in the operation are, that no Iron inſtruments be made uſe of in the whole proceſs; that the coals be not too large, duſty, or foul; and that the Stones be ſuffered to grow thoroughly cold before they are taken out of the furnace.

This Phoſphorus, like that of Balduin, appears luminous in the dark after being expoſed for a time to the ſun's light: if made in perfection, expoſure for a few minutes is ſufficient: The inferior kinds require ſometimes an hour or more. It proves more luminous when expoſed in a ſhady place, than to the direct rays of the ſun: Hot ſunſhine is apt to deſtroy its power. It has been diſtinguiſhed by different names; *Phoſporus bononienſis*, *italicus*, *mineralis*; *lapis lucidus* or *luminoſus*; *ignis frigidus*; *ſpongia ſolis*.

be pulveriſed in a glaſs-mortar, and the Powder made up into thin cakes with mucilage of Gum-tragacanth: A good wind-furnace being filled to about three-fourths its height with ſmall pieces of Charcoal, the cakes, thoroughly dried, are to be ſpread upon the unlighted pieces at top, and the furnace filled up with more Charcoal: After the fire has burnt out, the cakes are found on the grate, and may be eaſily freed from the aſhes that adhere, by blowing. The light of theſe maſſes is ſometimes white, ſometimes like that of a burning coal: A ſecond calcination generally increaſes their luminous quality.

Vitrification of gypſeous Earths.] The gypſeous Earths flow readily with Borax into a yellow Glaſs; with Sal Mirabile into a fine greeniſh yellow; but do not perfectly vitrify with other Salts, unleſs the quantity of Salt is large, and the fire extremely ſtrong. Mixtures of them with argillaceous Earths vitrify without any ſaline addition, eſpecially if expoſed to the immediate action of the fire. They do not melt with any pure Earth of the other claſſes; nor do they bake or cohere in the fire with any but the Cryſtalline.

CLASS

CLASS IV. ARGILLACEOUS EARTHS *and* STONES.

Earths forming with water a tenacious Paſte, or ſoft Stones;—burning hard (c);—corroded by ſtrong coction in the concentrated mineral Acids, but not acted on by moderate digeſtion.

I. BOLES.

THREE kinds of Boles are ranked among medicinal Earths, Armenian, red, and white. That met with in the ſhops under the name of Armenian is not the produce of Armenia or any of the oriental countries, but, like the others, of different parts of Europe, as Bohemia, Sileſia, Saxony, Hungary, BOL. ARM.

(c) *Tenacious Paſte—burning hard.*] Theſe are the properties of Clays on which their utility depends as the baſis of Earthenwares. When ſoftened with water they prove ſo ductile and coheſive, as to be formed with eaſe into any figure; and expoſed afterwards to the fire, they acquire a degree of hardneſs, which becomes greater and greater in proportion to the vehemence and continuance of the heat.

Pure Clay, ſoftened to a due conſiſtence for being worked, not only coheres together, but ſticks to the hands: in drying it contracts, an inch or more in twelve; and hence is very liable to crack, unleſs the exſiccation is performed exceeding ſlowly: in burning, it is ſubject to the ſame inconvenience, unleſs very gradually and equally heated. When thoroughly burnt, if it has eſcaped thoſe imperfections, it proves ſolid and compact, and ſo hard as to ſtrike fire with Steel: Veſſels made of it are not penetrated by any kind of liquid, and reſiſt Salts and Glaſſes brought by fire into the thinneſt fuſion, excepting thoſe which corrode and diſſolve by degrees the Earth itſelf, as Glaſs of Lead; and even this penetrating Glaſs, there is ſcarcely any other Earth that reſiſts ſo long: But in counterbalance to theſe good qualities, they want the whiteneſs and ſemitranſparency required in ornamental vaſes; and cannot be heated or cooled, but with ſuch precautions as can rarely be complied with in common buſineſs, without cracking or flying in pieces.

Clay that has once been expoſed to any conſiderable heat, and afterwards reduced to Powder, has no longer any degree of tenacity. Freſh Clay, divided by a due proportion of this Powder, proves leſs tenacious than by itſelf, not ſticking to the hands, though cohering ſufficiently together: It ſhrinks leſs in drying, is leſs apt to crack, and leſs ſuſceptible of injury from alternations of heat and cold; but at the ſame time leſs ſolid and compact. Conſiderable differences are obſerved in theſe reſpects, not only according to the quantity of the dividing matter, but according as it is in finer or coarſer powder.

Veſſels made with a moderate proportion of fine Powder, as half the weight of the Clay, are compact and ſolid, but ſtill very liable to crack from ſudden heat or cold. Thoſe with a larger proportion, as twice or thrice the quantity of the Clay, are free from that imperfection, but ſo friable as to crumble betwixt the fingers. Nor does there appear to be any medium betwixt a diſpoſition to crack or to crumble; all the compounds made of Clay and fine Powders, having one, or the other, or both imperfections.—Coarſer Powders, about the ſize of middling Sand, form with an equal weight of Clay, compounds ſufficiently ſolid, and much leſs apt to crack than the mixtures with fine Powders: Two parts of coarſe Powder and one of Clay, prove moderately ſolid, and but little diſpoſed to crack: A mixture of three-parts and one, though heated and cooled ſuddenly does not crack at all, but ſuffers very fluid ſubſtances to tranſude; ſolidity, and reſiſtance to quick viciſſitudes of cold and heat, ſeeming here alſo to be incompatible.

Different earthy matters, employed for dividing,

BOL. ARM. gary, Tranſylvania, France, Norway, *&c.* The French employ chiefly the Bole of Blois. We need not be ſolicitous about the particular place where any of the Boles have been dug, provided they are pure and of a good quality.

1. Bole

dividing Clay, agree nearly in theſe general mechanical effects: But they differ conſiderably in other reſpects, according to the chemical qualities of the particular Earth. (1.) Pure Clay, mixed with pure Clay that has been burnt, is no other than one ſimple Earth, and is neither to be melted, or ſoftened, or made in any degree tranſparent, by the moſt intenſe fires. (2.) Mixtures of Clay with gypſeous Earths burn whiter than Clay alone: In certain proportions, as two parts of Clay to three of Gypſum, they become in a moderate fire, ſemitranſparent; and in a ſtrong one they melt. (3.) Calcareous Earths, in ſmall proportion, bake tolerably compact and white; and added to other compoſitions, ſeem to improve their compactneſs. If the quantity of the calcareous Earth nearly equals that of the Clay, the mixture melts into a yellow Glaſs: If it conſiderably exceeds, the product acquires the qualities of Quick-lime. (4.) Veſſels made from Clay and Sand, in whatever proportion, do not melt in the ſtrongeſt fire; but they ſometimes bend or ſoften, ſo as to yield to the tongs: Glaſſes, in thin fuſion, penetrate them, by diſſolving the Sand: If gypſeous or calcareous Earths are urged in ſuch a crucible with a vehement heat, the veſſel and its contents run all into one maſs. In moderate fires, theſe veſſels prove tolerably compact, and retain moſt kinds of Salts in fuſion: But they are liable to crack, eſpecially when large, and do not long ſuſtain melted metals, being apt to be burſt by their weight: Such are the Heſſian crucibles. (5.) Flint forms whiter compounds than Sand, and hence is made uſe of as the dividing ingredient in the common white wares. (6.) Talc yields very compact maſſes, which freely ſtrike fire with Steel, and never melt or ſoften. (7.) Mixtures of Clay and Black-lead (which ſeem a ſpecies of Talc) are not liable to crack from alternations of heat and cold, but extremely porous: Hence Black-lead crucibles anſwer excellently for the melting of metals, and ſtand ſeveral repeated fuſions; whilſt Salts, flowing thin, tranſude through them, almoſt as water through a ſieve: Sulphureous bodies, as Antimony, corrode them. Theſe mixtures, when only moderately burnt, prove ſo ſoft as to be cut with a knife; a property for ſome purpoſes very valuable: Thus a door, *&c.* may be cut in a Black-lead pot, ſo as to make it a commodious portable furnace.

Pure Clay, ſoftened with water and incruſtated on earthen veſſels that have been burnt, does not adhere to them, or ſcales off again upon expoſure to the fire; applied to unburnt veſſels, it adheres and incorporates. Divided Clay unites with them in both ſtates.—Vitreous matters, melted in veſſels of pure Clay adhere ſo firmly as not to be ſeparated: From veſſels of divided Clay they may be knocked off by a hammer.

The ſaline ſubſtances which promote the fuſion of Clay, (beſides the common fluxes of all the Earths, Alcali and Borax) are chiefly Arſenic fixed by Nitre, and the fuſible Salt of Urine; both which have little effect on the other Earths though mixed with them in a large proportion. Nitre, which readily brings the cryſtalline Earths into fuſion; and Sal Mirabile and Sandiver, powerful fluxes for the calcareous, do not perfectly vitrify with Clay. Burnt Clay does not differ in theſe reſpects from ſuch as has not been burnt; nor in that ſingular property of vitrifying with gypſeous and calcareous Earths without any ſaline or metallic addition: The utmoſt vehemence of fire ſeeming to deſtroy only its ductility, or that power by which it coheres when pulveriſed and moiſtened with water. It is ſaid that Clay, added in the compoſition of common Glaſs, makes it tougher and leſs apt to crack.

The experiments from which the foregoing general reſults are drawn, were made with the tougher kind of tobacco-pipe Clay, which appears to be one of the pureſt of the Earths of this claſs. There is a great variety of Clays, differing in the degree of tenacity of the clay itſelf, as well as in the admixture

I. Bole Armenic is of a pale colour, between red and yellow, ſmooth and ſlippery to the touch, ſomewhat gloſſy, pure from Sand or any perceptible gritty matter. It readily crumbles betwixt the fingers, and adheres to the tongue. Softened with water, it forms a ſmooth Paſte: diluted with a larger quantity of water, it remains for a conſiderable time ſuſpended. BOL. ARM. Deſcription.

This Earth contains, beſides the purely argillaceous, a ſmall portion of one of a different claſs, which is extracted from it by Acids. In each of the following experiments were employed ſixty grains of the Bole. (1.) Spirit of Vitriol diſſolved eight grains: The ſolution was clear; the dried reſiduum grey. (2.) Spirit of Nitre diſſolved five grains: The ſolution appeared ſlightly yellowiſh; the reſiduum yellowiſh grey. (3.) Spirit of Salt, ſeven grains: The ſolution not green as Ettmuller relates, but of a Gold yellow; the reſiduum of a pale Sulphur yellow. (4.) Diſtilled Vinegar diſſolved but two grains: The ſolution was clear, but taſted bitteriſh, whilſt thoſe made in the mineral Acids were ſweetiſh: The reſiduum unchanged. (5.) Rheniſh Wine had the ſame effect as diſtilled Vinegar, except that the liquor proved in taſte leſs bitter. (6.) Freſh Citron juice diſſolved five grains: The liquor was clear, thickiſh, and had a kind of vitriolic taſte: The reſiduum unchanged. (7.) Alcaline Lixivia, diſſolved nothing; but the Bole was found to have abſorbed a part of the Alcali, appearing when dried of a darker colour, and weighing fifteen grains, or one fourth, more than at firſt. (8.) Spirit of Sal Ammoniac on the other hand diſſolved two grains of the Bole: The reſiduum unchanged. (9.) Lime-water had no effect. (10.) Rectified Spirit of Wine took up four grains, without occaſioning any further alteration. Examined by Acids, &c.

Four ounces of Bole Armenic, diſtilled in a glaſs-retort in an open fire, yielded three drams of a ſaline phlegm, which ſmelt a little urinous, and changed Syrup of Violets green. In the neck of the retort was found a little powdery ſaline matter, which had an ammoniacal taſte, but was in too ſmall quantity to be collected or further examined. Examined by diſtillation.

Bole Armenic, like moſt of the other coloured Earths, contains a portion of ferrugineous matter, to which its colour is owing, and which may be ſeparated by the magnet after the Bole has been calcined with Oil or other inflammable matters. It is likewiſe impregnated with vitriolic Acid: And hence, when mixed with Nitre or Sea-Salt, it extricates the Acids of thoſe Salts in the fire: Contains Iron, and vitriolic Acid.

admixture of heterogeneous matters. The ſteatitic Earths or Stones (ſee the following note) are no other than Clays, indurated, or deprived of their miſcibility with water: There are clays of all the intermediate degrees of toughneſs, from theſe to the viſcid Pipe-clay. The Sturbridge Clay appears nearly a medium betwixt theſe two extremes: Hence it is made into pots, for ſuſtaining the glaſs-houſe fires, without any addition to divide it; and cannot be worked, when mixed with ſuch large proportions of untenacious Powders, as the more viſcid Clays require. The loams or brick Earths are mixtures of Clay and Sand; The coloured Clays and loams participate of Iron: Hence many of theſe melt in a ſtrong fire without any addition; both Clay itſelf and mixtures of it with cryſtalline Earths being brought into fuſion by ferrugineous calces; though the fuſible mixtures of Clay and calcareous Earths are by the ſame ingredient prevented from melting. The bricks made from ſome loams, particularly the Windſor, are when moderately burnt, remarkably free, ſo as to be eaſily rubbed ſmooth, cut, ſawed, grooved, &c. Hence their uſe in building furnaces, &c. They bear a conſiderably ſtrong fire; but in a vehement one, I have often melted them.

BOL. ARM. fire: It was probably by the Acid of the Bole, that the alcaline Salt, in Exp. 7. was abſorbed and detained.

Medicinal uſe. This Earth is employed medicinally as a ſtyptic, both internally and externally; a virtue which ſeems to proceed from its ferrugineous impregnation: To the antipeſtilential and alexipharmac qualities, for which it has long been celebrated, it has no pretence: And the foregoing experiments ſufficiently evince, that the abſorbent ones, which ſome aſcribe to it, have no juſt foundation. It is prepared or purified by waſhing over with water; the pure Bole remaining ſuſpended for a conſiderable time ſo as to be poured off with the liquor, whilſt the ſandy or other groſſer matter remains behind: After the Bole has ſettled from the water, it is moderately dried, formed into rolls or cakes, and afterwards further exſiccated for uſe. Some have condemned this method of purification, as depriving the Bole of a certain central Salt. But this Earth contains nothing that water is capable of extracting: Bole Armenic treated with water, remained undiminiſhed in weight; and neither the Bole or the water received any ſenſible alteration.

RED BOLE. II. The common red Bole is coarſer than the Armenian, and participates more largely of Iron: Hence it is never given internally unleſs to cattle. I

Examined by Acids, &c. examined it in the ſame manner as the Armenian; employing, with each menſtruum, ſixty grains of the Earth. (1.) Spirit of Vitriol diſſolved five grains: The Solution taſted like Vitriol of Iron: Its colour was white, that of the remaining Bole browniſh grey. (2.) Spirit of Nitre diſſolved ſeven grains: The ſolution was yellowiſh, and of a vitriolic taſte; the reſiduum yellowiſh brown. (3.) Spirit of Salt diſſolved ſix grains: The liquor deep yellow, and of a vitriolic taſte; the reſiduum yellowiſh white. (4.) Diſtilled Vinegar took up but three grains: The liquor clear and ſweetiſh; the reſiduum rather darker coloured than the Bole was at firſt. (5.) Citron juice extracted five grains, and left the Bole ſomewhat paler: The liquor had an earthy kind of taſte. (6.) Rheniſh Wine diſſolved no more than one grain: The remaining Bole unchanged. (7.) A ſtrong fixt alcaline Lixivium received no tincture from the Bole, but was in part abſorbed by it; the dried matter weighing twelve grains more than the Earth employed; its colour was ſomewhat darker. (8.) Spirit of Sal Ammoniac diſſolved two grains: The liquor was clear; the remaining Bole ſomewhat darker. (9.) Lime-water diſſolved three grains. (10.) Rectified Spirit of Wine two grains. (11.) Common water had not the leaſt effect.

By diſtillation. Four ounces of red Bole, diſtilled in an open fire, yielded two drams and a half of urinous phlegm; the remaining Bole preſerving its original colour. On previouſly digeſting the Bole with a ſaturated alcaline Lixivium, ſomewhat more of the urinous matter was produced, and the diſtilled liquor had a volatile ſmell; an experiment which may deſerve further conſideration.

W. BOLE. III. The white Bole is brought to us ready waſhed and formed into large rolls or cylindric glebes, not of a chalky whiteneſs, but rather of an aſh colour. Formerly it came only from Tuſcany or the iſland Elva: At preſent it is ſupplied chiefly from Norway, the iſland Bornholm, or places nearer home.

It differs from the two preceding in containing no manifeſt irony matter, and conſequently in wanting their aſtringency. It has been recommended as an abſorbent; but experiments made upon it with Acids ſhew that it little deſerves that character, any more than the other Boles. Some have a method of recovering the luſtre of Pearls, eſpecially the Scotch ones, by warming them a little over the fire, and rubbing them with powdered white Bole. BOLE. Pearls cleaned.

Out of ſixty grains of this kind of Bole, (1.) Spirit of Vitriol diſſolved four grains: The ſolution was clear, and had ſcarce any vitriolic taſte; the reſiduum grey. (2.) Spirit of Nitre diſſolved ſix grains: Both the liquor and the reſiduum looked yellowiſh. (3.) Spirit of Salt, five grains: Both the Menſtruum and the Bole unaltered in colour. (4.) Diſtilled Vinegar, two grains: The liquor clear, the Bole unaltered. (5.) Citron juice, ſix grains: The ſolution taſted bitteriſh; the Earth looked ſomewhat darker. (6.) Rheniſh Wine took up nothing, but ſomewhat darkened the colour. (7.) Fixt Alcali was in part retained, as by the other Boles; increaſing the weight ten grains, or one ſixth. (8.) Spirit of Sal Ammoniac diſſolved three grains; the liquor appeared tinged a little; the Bole ſomewhat darker. (9.) Lime-water diſſolved two grains; the liquor clear, the Bole unchanged. (10.) Rectified Spirit of Wine diſſolved four grains, and left the Bole unaltered. (11.) Pure diſtilled water took up three grains; but the part diſſolved gradually fell down again, not in the form of powder, but what is pretty remarkable, in flakes reſembling a kind of mouldineſs. White Bole examined by Acids, &c.

Four ounces of white Bole yielded in diſtillation only one dram and a half of a yellowiſh phlegmatic liquor, which ſmelt ſomewhat empyreumatic, and changed Syrup of Violets green: The Caput Mortuum was grey.

II. TRIPOLI.

THIS Earth, brought perhaps at firſt from Tripoli in Barbary, is now found in ſeveral parts of Europe; in the iſland Corſica, Iſchia, at Bayonne, in Spain, in ſeveral hills in France, particularly at Poligny near Rennes in Britany, where it lies in Strata about a foot thick. It is always of a yellowiſh colour, commonly about the ſhade called an Iſabella yellow, ſometimes paler, ſometimes deeper, or variegated with darker ſtreaks inclining to reddiſh. The beſt ſort is ſoft and eaſily rubbed, yet compact and not very powdery, free from Sand or Gritt, of no taſte or ſmell, and not very heavy. It burns hard like the common potter's Earth, from which it differs little otherwiſe in quality, than in being more difficultly vitreſcible. Its principal uſe is for the poliſhing of metalline utenſils, optic glaſſes, &c. Some have employed it in the diſtillation of acid Spirits, but very unfrugally; common Loams and Brick earths being fitter for that purpoſe, as well as cheaper. Stahl made uſe of it in an ointment for the itch, which I prepared for him here, and which was compoſed of an Amalgam, ground firſt with as much Tripoli as rendered it pulverable, and then mixed with the camphorated white Ointment. TRIPOLI. Natural Hiſtory. Chemical Hiſtory.

Two ounces of powdered Tripoli, diſtilled in a glaſs retort in an open fire, yielded at laſt two ſcruples of a weak Spirit of Salt; and in the neck of the

TRIPOLI. retort was found a little blackiſh Sal Ammoniac: The reſiduum weighed four ſcruples leſs than at firſt. Mixed with Nitre, it extricated the Acid of that Salt, and gave over its own marine Acid; the diſtilled liquor proving an Aqua Regia, and diſſolving Gold. Out of ſixty grains of Tripoli, Oil of Vitriol diſſolved only one grain; Spirit of Vitriol, two; Spirit of Salt, three; Spirit of Nitre, five; and Aqua Regis, eleven. The ſolutions in the vitriolic and marine Acids were colourleſs: That in the nitrous, yellowiſh; and that made with Aqua Regis, of a deeper yellow, the Earth remaining white. Diſtilled Vinegar, and fixt and volatile Alcalies, had no effect: But the Cauſtic fixt Alcali diſſolved ſeven grains.

III. LAPIS NEPHRITICUS. (*d*)

NEPHRIT. THE Lapis Nephriticus is a ſoft, brittle, opake Stone, not ſuſceptible of a good poliſh, ſmooth and as it were unctuous to the touch, variegated with different colours, among which green is the principal. It is found in New

Natural Hiſtory.

(*d*) *Lapis Nephriticus.*] The Lapis Nephriticus is a ſpecies of the indurated Clays called from their unctuoſity, *Steatitæ:* With theſe it agrees not only in its obvious properties, but likewiſe in its burning hard, the grand character of argillaceous Earths. Its green colour ſeems to proceed from Copper: Pott relates, that on fuſion with an equal quantity of Borax, it yielded a beautiful red maſs, reſembling an agate, with a grain of Copper at the bottom. It is conſiderably the hardeſt of the ſubſtances of this claſs.

The Steatites, or Sope-rock, is ſaid to be plentiful in ſome parts of England, particularly in Cornwall. It is in general ſo ſoft as to be eaſily cut with a knife, and turned in a lathe. Among the Griſons in Swiſſerland, it is turned into pots for culinary uſes, by a pointed tool moved round by a mill; whence the Stone is called *Lapis ollaris:* It is ſaid that a great number of theſe veſſels are cut out of one maſs, with ſuch nicety, that they all fit exactly into one another again, and appear but one; that they are very durable; and that when cracked, they are joined by Iron wire. The author abovementioned obſerves, that childrens Marbles, and the China figures, are made of Steatitæ: And ſuſpects, that the heads, ſtatues, and other monuments of ancient artiſts, whoſe elegance, hardneſs, and durability are the admiration of ours, were cut from ſome of the ſoft ſteatitic Earths; which after having freely yielded to the tool and received the form, acquired from fire the hardneſs of Stones, and were finally embelliſhed with the poliſh which they ſtill retain. Thus much is certain, that the Steatitæ burn to a great degree of hardneſs, ſo as to ſtrike fire in abundance with Steel, and bear a fine poliſh; and that the ancients were well acquainted with theſe Stones and their properties. Theophraſtus expreſsly mentions a Stone found at Siphne, ſo ſoft as to be uſed by the ſculptor and turner, and cut into veſſels for the table, and which when heated and impregnated with Oil became very black and ſolid.

The greyiſh and pale greeniſh Steatitæ commonly burn white in an open fire, but in cloſe veſſels yellow: The yellow ſorts burn red, as participating of Iron, which on digeſtion in Aqua Regis is extracted, and tinges the menſtruum yellow. Thoſe which are naturally pure from Iron, or have been purified from it by Aqua Regia, melt with twice their weight of fixt Arſenic into a fine yellow Glaſs; and with equal their weight of Borax, into a greeniſh one, not ill reſembling the Beryl. With Clay they form a compound extremely hard, and of great whiteneſs. Theſe experiments were made by Mr. Pott on the Steatites of Bareuth in Franconia, there called *Schmeerſtein*, *Speckſtein*, *Meelbatz*; and by me, with the ſame ſucceſs, on the maſſes met with in the ſhops under the name of French Chalk, ſo called perhaps from their drawing white lines on cloth.

New and Old Spain, in Swifferland, Bohemia, and Saxony. From its imaginary medical virtues againſt nephritic diſorders, it has been ranked among the precious Stones; but in all its ſenſible qualities it is very far removed from thoſe of that claſs. It is ſurprizing that Hernandez, De Boot and others, ſhould have referred it even to the Jaſpers, the Agates, or the Marbles; from all which it is extremely and obviouſly different: Though it has the green ſpecks of the Jaſpers, it never has their red ones: It wants the hardneſs and compactneſs of thoſe Stones; and they, the unctuoſity or ſopineſs of the Nephritic. Profeſſor Nebel, in 1733, publiſhed a diſſertation on a new nephritic Stone: But this, from his own account of it, and the ſpecimen ſent me, appears to be an entirely different one; having neither the green colour, the ſpecks, the ſopineſs, nor any of the characters of the Lapis Nephriticus. NEPHRIT.

On examining the nephritic Stone by Menſtrua, nothing very remarkable was obſerved; except that a part of it was extracted by all Acids, and by ſome a very conſiderable one. Out of ſixty grains, diſtilled Vinegar diſſolved three, Oil of Vitriol, ſeven, Spirit of Vitriol fourteen, Spirit of Nitre ſixteen, Aqua Regia eighteen, and Spirit of Salt twenty. The Spirit of Salt acquired a greeniſh yellow Tincture, Aqua Regia a Gold yellow, Oil of Vitriol a dark browniſh; the other Acids remained colourleſs. Both the marine Acid and Aqua Regia left the undiſſolved Earth whitiſh, the nitrous Acid greyiſh, the diluted vitriolic Acid browniſh yellow, the concentrated light reddiſh brown; the acetous, unchanged. Examined by Menſtrua.

An ounce of powdered Lapis Nephriticus, diſtilled in a retort in an open fire, yielded about a dram and a half of phlegm, which had a penetrating empyreumatic ſmell, and made no change in the colour of Syrup of Violets. On diſtilling four ounces, I had an appearance of an actual empyreumatic Oil; with a ſaline matter, which was found to be Sal Ammoniac; for it effervеſced with Oil of Vitriol and emitted fumes reſembling thoſe of Spirit of Salt, and with fixt Alcali it yielded urinous vapours. The matter remaining in the retort was of a reddiſh-brown colour. By diſtillation.

An ounce of the powdered Stone, mixed with an equal quantity of fixed alcaline Salt, and urged with a ſtrong fire, did not melt; but formed a quite porous maſs, in colour inclining to reddiſh grey, and weighing two drams leſs than the mixture did at firſt.

CLASS V. TALKY EARTHS *and* STONES.

Earths, or ſoft ſtony concretes;—not acted on by any Acid;—and ſcarce calcinable by fire.

I. VENICE TALC.

VENICE Talk is a ſoft ſmooth concrete, unctuous or ſopy to the touch, of a whitiſh or pale greeniſh colour, with a Silver-like luſtre, generally found in ſmall pieces. It may be ſplit into numerous fine plates or leaves; which, ſingly, prove ſomewhat flexible and elaſtic, and perfectly pellucid, though the entire maſs is commonly opake, or at moſt only ſemitranſparent. TALC. Natural Hiſtory.

TALC. parent. The ſmalleſt pieces are to be preferred; the larger, however white and apparently pure on the outſide, being apt to have ſpecks or veins of heterogeneous matter in the internal part. This mineral has received the epithet Venetian, not from its being originally the product of Venice, but probably from that city having formerly been a principal mart for it. Though it may perhaps be met with in ſome parts of the Venetian dominions, it is more common in other countries; in Muſcovy, England, Norway, Hungary, Bohemia, Spain, and the Eaſtern nations.

Effect of fire on it. Talc is generally ſuppoſed to be entirely unſubduable by fire. But Mr. Boyle relates, that having kept ſome Venice Talc for a length of time in a glaſs-houſe furnace, it loſt of its volume, its compactneſs, and its luſtre, and became more brittle, though it ſtill retained the appearance which it had at firſt. I have myſelf alſo obſerved a like effect, the Talc by ſtrong calcination having loſt its luſtre and unctuoſity, though the diminution in weight was only one dram upon ſix ounces: Some white vapours aroſe in the calcination, reſembling thoſe of the Acid of Sea-Salt, but no ſpirit could be collected on repeating the operation in a retort; the Talc here loſt nothing of its weight, but had contracted a blackiſh hue. Morhoff, in his epiſtle to Langelott on the tranſmutation of metals, declares that he has ſeen Talc, in the ſpace of half an hour and by a ſmall fire, calcined into a ſpongy maſs, friable betwixt the fingers into a ſubtile Powder. Charas has already queſtioned this experiment, and we may be certain it was not performed on any true Talc: Probably the Lapis Specularis, or Selenites, were miſtaken for Talc; a ſuſpicion which is countenanced by the author's own words: He ſays the mineral was deprived of its yellow colour, a colour which thoſe Stones frequently have, but Venice Talc has not. Though Talc however in great meaſure reſiſts the action of culinary fire, I have found it incapable of reſiſting the concentrated ſolar heat: A piece of the true Venice Talc, expoſed to the focus of Tſchirnhaus's large burning lens, preſently melted into an untranſparent vitreous maſs.

Examined by Menſtrua. I have examined Talc with all the mineral Acids, and with alcaline Lixivia, which ſome report to have a greater action on it; but without finding that either of them had any action at all; the Talc remaining undiminiſhed in weight, and neither the Talc or the liquors ſuffering any ſenſible alteration. I have calcined it alſo with Sulphur, with Sulphur and common Salt, with Nitre, with Sal Ammoniac; without any other effect than a little change in its colour. On trying to melt it with twice its weight of Borax, the Talc fell to the bottom as ſoon as the Borax came into fuſion. Alcaline Salts, and Cauſtic Alcalies taken in four times the weight of the Talc, ſucceeded no better; this refractory Earth refuſing to unite with them: The Salts being afterwards deliquiated in the air, the addition of Acids occaſioned no precipitation, which they muſt have done if the Alcalies had taken up in fuſion any part of the Talc (*e*).

with fluxes.

Talc

(*e*) *Vitreſcibility of Talk.*] The author ſeems to have failed in theſe experiments from uſing too large a proportion of the Salts, and too weak a heat. Venice Talc, with half its weight of alcaline Salt, may, in a ſtrong fire, be brought into perfect fuſion, though

Talc is employed, in thoſe places where it is found in any conſiderable quantity, in compoſitions for earthen veſſels; and by ſome for teſts and cupels. From its ſmoothneſs, unctuoſity, and brightneſs, it has been greatly celebrated as a coſmetic; and the chemiſts have ſubmitted it to a variety of operations, for procuring from it Oils, Salts, Tinctures, Magiſteries, &c. for that intention. But all their labours have been in vain; and all the preparations ſold under the name of Talc have either contained nothing of that mineral, or only a fine Powder of it. Oleum Tartari per deliquium, Vinegar of Litharge, Solution of Sugar, Oil of Almonds, or Oil of Ben with Sugar of Lead, have been put off under the ſpecious name of Oils of Talc. Otto Tachenius pretended the Terra foliata Tartari to be an artificial Talc; and accordingly vended, for Oil of Talc, a Solution of that Salt. Dr. Behms Ointment of Talc, which had a large run in Venice, I found to be no other than Pomatum mixed with a little powdered Talc. TALC. Uſes.

The pulverization of this mineral is attended with ſome difficulty. The more brittle pieces may be pulverized pretty eaſily; but the very tough and flexible ſcarce at all; nor is heating the mortar and peſtle red-hot, which ſome recommend, of any advantage. The moſt commodious method of reducing it into fine Powder is, by cautiouſly filing, or grating it with a fiſh-ſkin. Pulverization.

II. SOLAR TALC.

BESIDES the white and the greeniſh Talcs treated of in the foregoing article, there are yellow, red, and black foliaceous concretes diſtinguiſhed by the ſame name; but theſe are in general rather of the gypſeous than talky kind. Thus the black Talc, mentioned by Hoffmann, which laid on burning coals falls into leaves and acquires a golden colour, ſeems to be a ſpecies of Lapis Specularis. Thoſe of a yellow colour have been called ſolar Talcs, and imagined to be impregnated with a ſulphur of Gold; which ſome of the chemiſts have pretended to extract by Spirit of Salt or Aqua Regis. But the yellow tincture which theſe minerals communicate, and the red ſublimate which ariſes on diſtilling the ſolutions, proceeds entirely from a ferrugineous matter, common to theſe with other coloured Earths. S. TALC.

though not to perfect tranſparency: With equal its weight, or leſs, of Borax, it runs into a beautiful, pellucid, greeniſh yellow Glaſs. Talc does not melt with any other Earth, nor even bake or cohere with any but the argillaceous: Mixtures of it with them all are nevertheleſs brought into fuſion by a remarkably leſs quantity of ſaline matter than the ingredients ſeparately would require. Thus equal parts of Talc and Chalk, with only one fourth their weight of Borax, melt, in no very vehement fire, into a fine tranſparent, greeniſh Glaſs, of conſiderable hardneſs, and great luſtre. On ſubſtituting gypſeous Earths, as the Lapis Specularis, to Chalk, the fuſion was as eaſy, and the Glaſs as beautiful, in colour not green but yellow like the Topaz. Talc with half its weight of Sand, and a quantity of Nitre equal to both, yielded alſo a tranſparent Topaz-yellow Glaſs: Several further experiments on Talc may be ſeen in a Memoir by Mr. Pott (*Mem. de l'Acad. de Berlin*, 1746,) from which I have here inſerted only thoſe which I repeated myſelf, and which were all found fully to ſucceed.

III. AMIANTHUS.

AMIANT. AMIANTHUS and Aſbeſtus are ſtony concretes of the talky kind, though differing from Talc in their external appearance. They are not near ſo bright, or ſo ſmooth and unctuous; and are compoſed not of leaves or plates, but of long filaments like flax; whence they have been called Earth-flax, *Linum Aſbeſtinum*. They have been ſpun into Cloth, and formed into Paper, incombuſtible and indeſtructible in the fire (*f*).

IV. PUMICE.

PUMICE. THE Pumice is a light very ſpongy Stone, rough to the touch, and eaſily rubbed into Powder. The beſt ſort is of a white or greyiſh colour: Some have a yelloviſh, browniſh, or blackiſh tinge. Boccone mentions a red Pumice from Radicofani, but probably miſtook ſome other Stone for this: I have myſelf ſeen there abundance of reddiſh Stones, but no Pumice. The Pumice is found only about Volcano's, and appears to owe the form in which we meet with it, to ſtrong calcination by the ſubterraneous heat. It is thrown out from the Volcano, along with the fire and lava, in pieces of various figures and magnitudes, ſometimes pure, and ſometimes intermixed with the other matter. Sometimes it is taken up in the adjacent ſeas, and hence has been erroneouſly ſuppoſed by ſome to be a marine production; to be petrified ſponge, or the froth of the ſea coagulated and indurated with Sand or other ſubſtances. The whiteſt Pumices come from Ætna and Veſuvius: Hecla in Iceland affords more impure ſorts.

Natural Hiſtory.

Examined by Acids. Pumice Stone is ſaid by Ettmuller to be an alcaline abſorbent. A part of it is indeed diſſolved or extracted by Acids: Out of thirty grains of the powdered Stone, Oil of Vitriol diſſolved ſix grains, Spirit of Vitriol ten, Spirit of Nitre

(*f*) *Incombuſtible Paper and Cloth.*] There are ſome ſorts of Aſbeſtos whoſe filaments are rigid and brittle; others more flexible: The firſt are not at all to be ſpun or formed into Cloth, and the latter very difficultly. This manufacture appears to have been known among the ancients, who according to Pliny wrapt the corps of the dead in aſbeſtine clothes to preſerve their aſhes ſeparate from thoſe of the funeral pile; an uſe to which they are ſtill ſaid to be applied among the princes of Tartary. The method of preparation, as deſcribed by Ciampini in the Philoſophical Tranſactions, N° 273, is as follows. The Stone is laid to ſoak in warm water, then opened and divided by the hands, that the earthy matter may be waſhed out: This Earth is white like Chalk, and renders the water thick and milky. The ablution being ſeveral times repeated, the flax-like filaments are collected and dried: They are moſt commodiouſly ſpun with an addition of Flax: Two or three filaments of the Aſbeſtos are eaſily twiſted along with the Flaxen-thread, if the operator's fingers are kept oiled: The Cloth alſo when woven is beſt preſerved by Oil from breaking or waſting: On expoſure to the fire, the Flax and the Oil burn out, and the Cloth comes out pure and white. Probably from the diſſipation of ſome extraneous matter of this kind proceeded the diminution of weight which an aſbeſtine napkin ſuffered in the fire, in an experiment made before the Royal Society; for pure Aſbeſtos loſes nothing.—The ſhorter filaments which ſeparate in waſhing the Stone may be made into Paper in the common manner.

Nitre nine, Spirit of Salt and Aqua Regis each eleven, and diſtilled Vinegar ten: But all the liquors retained their acidity as ſtrong as if they had taken up nothing from the Pumice; nor did they raiſe with it any efferveſcence. It is acted on more powerfully by Alcalies themſelves than by Acids: Fixed alcaline Lixivia diſſolved fifteen grains out of the thirty; and volatile Spirits twelve grains. PUMICE.

The Solutions in Acids are all colourleſs; except that made with the vitriolic, which inclines to yellow. The author above-mentioned relates, that diſtilled Vinegar extracts from Pumice a greeniſh tincture; and hence ſuſpects that this Stone is impregnated with Copper. I have never obſerved the ſlighteſt green tincture, but from ſuch as had been pulverized in a braſs mortar.

Sixteen ounces of Pumice, diſtilled in a retort, yielded an acid liquor, and a viſible empyreumatic Oil, of an extremely ſtrong ſmell, amounting both together to half an ounce and one ſcruple: In the neck of the retort was found about a ſcruple of true Sal Ammoniac, of a browniſh-grey colour. The reſiduum appeared of a blackiſh grey, and weighed about fifteen ounces. Half an ounce, calcined in a crucible, in an open fire, loſt a ſcruple, or one twelfth. By diſtillation.

The principal uſe of Pumice is in mechanic buſineſſes, for ſcouring, cleaning and poliſhing metals, Leather, *&c.* It is ſometimes alſo employed in dentifrices. The pumice Powder with which Gold has been poliſhed, as retaining ſome particles of that metal, is ſaid by the author of *Sol ſine veſte* to afford a ruby Glaſs. Uſes.

SECT. II.

METALLIC BODIES.

METALLIC Bodies are divided into *Metals*, or thoſe which are capable of being worked and conſiderably extended under the hammer; and *Semi-metals*, or thoſe which want that valuable quality. There are other characters alſo, no leſs diſcriminative of the two claſſes: Metals appear when broke of an uniform, or a fibrous, or a granulated texture; whilſt the broken ſurfaces of Semi-metals (the fluid one, Quick-ſilver, excluded) are compoſed of large angular plates or flakes: Metals, expoſed to the moſt intenſe degree of culinary fire, if the air is perfectly ſhut out, remain fixed and unaltered at the bottom of the veſſel; whilſt Semi-metals, impatient of vehement heat, ariſe in fumes into that part of the veſſel which is furtheſt removed from the fire, and there condenſe again into their original form. METALS. Diſtinguiſhing characters of Metals and Semi-metals;

Though neither Metals or Semi-metals ſuffer any eſſential change from heat, ſo long as the air is excluded; there are ſeveral bodies of both claſſes, which by the action of fire and air conjointly, are gradually deprived of their metallic of perfect and imperfect Metallic Bodies.

METALS. metallic appearance and qualities, and converted into a powdery or vitreous ſubſtance, called *Calx* or *Scoria*. Hence ariſes a further diſtribution, into *Imperfect*, or thoſe which are ſuſceptible of theſe changes; and *Perfect*, or thoſe which ſuffer none.

CLASS I. PERFECT METALS.

Malleable metals;—not calcining in the fire, either by themſelves, or with the addition of Nitre, or of Lead, which haſten the deſtruction or calcination of the imperfect;—when corroded by Acids into the appearance of a Calx, recoverable again in their priſtine form, without addition, or with only ſuch additions as may abſorb the Acid.

I. GOLD.

GOLD. GOLD (the *Sol* and *Rex metallorum*, of the chemiſts) is a yellow metal ſcarce at all elaſtic or ſonorous, very ſoft and flexible, the moſt ductile of all metallic bodies. Dr. Halley took one grain of gilt Silver, of which only one forty-eighth part was Gold: This grain was drawn into a wire two ells in length, which examined by a microſcope, appeared every where covered with the Gold: A piece of the wire being put into Aquafortis, the Silver was eaten out, and a tube of Gold remained, which notwithſtanding its extreme thinneſs, was ſtill opake.

Its general properties, Ductility,

Gravity, Gold is of all natural bodies the moſt ponderous: Hence it ſinks in Quickſilver, whilſt all other ſubſtances [Platina excepted] ſwim on the ſurface. It is upwards of nineteen times heavier than an equal bulk of water: A Paris cubic foot is reckoned to weigh 1368 pounds (*a*). From its greater denſity it becomes ſenſibly hotter than other bodies when laid along with them in hot water.

Fuſibility, Gold melts in a red heat; much ſooner than Copper or Iron; though much later than Lead or Tin (*b*). It is of all metals the moſt fixed or permanent in the

(*a*) *Gold—Gravity.*] The proportional gravity of Gold to water has been reported to be as 19,640 to 1: Mr. Browal, in the Swediſh Tranſactions, makes it no leſs than 20. In ſundry trials, with different pieces of the fineſt Gold I have been able to procure, the gravity turned out between 19,280, and 19,290.

(*b*) *Gold—in the fire.*] Gold requires for its fuſion a ſtrong red, or a low degree of white heat, a little greater than that in which Silver melts. Whilſt fluid, it appears of a bluiſh green colour: When grown cold, its ſurface looks bright, ſmooth, and conſiderably concave. It ſeems to expand more in the act of fuſion, and to ſhrink more in its return to ſolidity, than any of the other metals; whence the greater concavity of its ſurface. Before fuſion, it expands the leaſt of any except Iron. By ſudden cooling, it becomes, as the other metals, brittle; an effect, which has been, in general, erroneouſly attributed to the contact of fuel during fuſion.

With other Metals.] Gold amalgamates very readily with Mercury, and mingles in fuſion with all the metals. It is remarkably diſpoſed to unite with Iron; of which it diſſolves many times its own weight, in a heat

the fire: An ounce has been kept for two months together, in a glaſs-houſe furnace, which of all furnaces gives the moſt vehement heat, without ſuffering the leaſt diminution of its weight. Homberg relates, that in the focus of Tſchirnhaus's large burning-glaſs, it loſt its fixity; that it ſmoked, diminiſhed in volume, changed into a red Earth, and at laſt even vitrified: But as the Gold had been placed on a piece of Charcoal, the vitreous matter probably proceeded from the aſhes of the coal. Mr. Geoffroy often aſſured me, whilſt we were making experiments together with the ſame burning lens, that no ſuch vitrification had been obſerved, when any thing beſides Charcoal was uſed for the ſupport. GOLD. Fixity, Expoſed to a burning-glaſs.

Gold diſſolves in a mixture of the nitrous and marine Acids, called, from its action on this *Rex Metallorum*, Aqua Regia: Either of thoſe Acids ſingly have no effect upon it; nor is it acted on by the the vitriolic. Boerhaave ſays that Sea-Salt or Sal Gem are the only menſtrua of Gold; and that both theſe Salts diſſolve it, whether applied in the form of a Lixivium or Spirit: Experience affords no foundation for this aſſertion (*c*). The ſolution in Aqua Regis is of a Gold Solution.

a heat not much greater than that in which Gold by itſelf melts: The mixture is of a ſilver colour, very brittle, and hard. All the metals, except Copper, debaſe the colour of Gold; and if their quantity is nearly equal to that of the Gold, almoſt entirely conceal it. All but Copper and Silver deſtroy its malleability; none ſo remarkably as Tin and Lead: A moſt minute portion, even the vapour, of theſe renders Gold extremely brittle; though a ſmall proportion of Gold forms with them compounds ſufficiently ductile, more ſo than either the Lead or Tin by themſelves.

(*c*) *Solubility in Acids.*] Gold is commonly ſuppoſed incapable of being diſſolved in any ſimple Acid. It appears however to be ſoluble, in certain circumſtances, both by the nitrous and marine, though not ſo readily or plentifully as by a mixture of them.

Dr. Brandt produced before the Swediſh academy of ſciences a ſolution of it in the nitrous Acid, obtained in parting, by that Acid, a mixture of Gold and Silver. The mixed metal was boiled with Aquafortis in a glaſs body fitted with a head and receiver, the liquor poured off, and the coction repeated with freſh parcels of ſtronger and ſtronger nitrous ſpirits, till all the Silver was judged to be extracted: The laſt parcel was boiled down till the matter at the bottom looked like a dry Salt; on boiling this in freſh Aqua fortis, in cloſe veſſels as before, a part of the Gold was diſſolved, and the liquor tinged yellow. See the Swediſh Tranſactions for the year 1748. But though Gold is by this means truly diſſoluble in the nitrous Acid, the union betwixt them is extremely ſlight; the Gold being not only precipitated on the addition of Silver, or ſuch other metals as diſſolve in that Acid, but likewiſe ſubſiding ſpontaneouſly upon expoſure to the air.

The marine Acid has no action on Gold in its metallic ſtate, in whatever manner the Acid be applied: But if the metal is previouſly attenuated, or reduced into the form of a Calx, either by precipitation from other Menſtrua, or by calcination in mixture with calcinable metals, this Acid will then perfectly diſſolve, and keep it permanently ſuſpended. Gold precipitated from Aqua Regis by fixed Alcalies, and edulcorated by ablutions with boiling water, I have diſſolved even in a very weak Spirit of Salt by moderate digeſtion. This ſolution appears of the ſame yellow colour, as that made in Aqua Regis: It gives the ſame purple ſtain to the ſkin, feathers, bones, and other ſolid parts of animals; the ſame Violet ſtain to Marble; and ſtrikes the ſame red colour with Tin. Even when common Aqua Regia is made uſe of for the menſtruum, it ſeems to be chiefly by the marine Acid in that compound liquor, that the Gold is held in ſolution: In diſtillation, it is the nitrous Acid which ariſes;

GOLD. a Gold yellow colour, and ſtains the ſkin, where-ever it touches, of a fine purpliſh red, which is not eaſily got off.

changes of its properties by art,

Singular and unalterable as the properties of Gold appear to be, they are eaſily maſtered by chemiſtry. A ſingle grain of Tin will deſtroy the ductility of a thouſand grains of Gold; rendering the moſt malleable Gold not only incapable of being extended, but of bearing the hammer at all. In Kunckel's *Laboratorium Chymicum*, there are proceſſes by which Gold may be ſublimed and diſtilled over the helm; and ſurely what ſublimes or diſtils has loſt its fixity. Mercury-ſublimate and Sal Ammoniac volatilize it (*d*). There is a certain common and well known ſubject, plentifully made uſe of by every body, which robs Gold of its luſtre, its colour, and its malleability, and renders it white and brittle: But this ſubſtance, as it might give riſe to abuſes, I forbear to name. Gold melted repeatedly with Borax, becomes paler and paler on every fuſion; and there are ſundry other ſubſtances, as Butter of Antimony, Zinc, and the ſmoking Spirit of Tin, from which it ſuffers notable alterations. After all theſe changes however, it is ſtill reducible to its original ſtate: The brittle, the white, the ſublimed, the diſtilled Gold, may all be reſtored to the purity and properties of the Gold at firſt. The chemiſts have long laboured in the deſtruction of this metal, and allow it to be eaſier to make Gold than to deſtroy it; though it does not appear, that either of theſe problems is entirely beyond the reach of art: For a little Gold has in divers experiments been produced; and Gold was deſtroyed in the preſence of Mr. Boyle (*e*).

whether deſtructible or producible.

Aqua

and the marine which remains combined with the Gold into a blood-red maſs, ſoluble, like the combinations of moſt metallic bodies with that Acid, in Spirit of Wine.

(*d*) *Volatilization of Gold.*] The volatilization of Gold, though it has been looked upon as one of the proceſſes of the ſublimer metallurgy, may be effected without difficulty. If a ſolution of Gold in common Aqua Regia be inſpiſſated, the reſiduum diſſolved in freſh Aqua Regis, and the liquor diſtilled off: Upon haſtily increaſing the fire towards the end of the operation, part of the Gold diſtils in form of a high Saffron-coloured liquor, and part ſublimes into the neck of the retort, in cluſters of long ſlender Cryſtals, of a deep red colour, fuſible in a ſmall heat, eaſily ſoluble in water, and deliquiating in the air. By repetitions of the proceſs, the whole quantity of the Gold may thus be elevated, excepting a ſmall proportion of white Powder, whoſe nature and qualities may deſerve further examination.

(*e*) *Boyle's degradation of Gold.*] The experiment, here referred to, is a very curious and extraordinary one, though it falls ſhort of proving the deſtructibility of Gold. About one eighth part of a grain of a Powder communicated by a ſtranger, was projected upon two drams of fine Gold in fuſion, and the matter kept melted about a quarter of an hour. During the fuſion, the metal looked like ordinary Gold: When cold, it appeared of a dirty colour, and as it were overcaſt with a thin coat almoſt like half vitrified litharge: The bottom of the crucible was overlaid with a vitrified ſubſtance, partly yellow, and partly reddiſh brown; with a few ſmall globules, more like impure Silver than Gold. The metal was brittle, internally like Braſs or Bell-metal, on the touchſtone more like Silver than Gold: Its ſpecific gravity was to that of water only as $15\frac{1}{3}$ to 1. There was no loſs of weight.

Though the Gold was ſurprizingly altered in this experiment, it was not deſtroyed: Mr. Boyle himſelf informs us, that ſixty grains of the maſs yielded on cupellation fifty-three grains of pure Gold; with ſeven grains of a fixed, ponderous, dark coloured ſubſtance: And probably this laſt, by proper treatment, might likewiſe have been reduced into Gold again.

GOLD.

Aqua Regia, the proper menſtruum of Gold, is commonly prepared by diſſolving one part of Sal Ammoniac in four of Aqua fortis or Spirit of Nitre. Kunckel directs a commodious method of obtaining the exact proportions neceſſary for the ſolution: The Gold, either in form of leaves, or granulated, or flatted into thin plates, then made red-hot and cut in ſmall pieces, is to be put into a ſuitable quantity of Aqua fortis, a gentle heat applied, and ſome powdered Sal Ammoniac added gradually, by little and little at a time, till the whole of the Gold is diſſolved (*f*).

Commodious method of diſſolving it,

There are, beſides this, ſome uncommon and curious ſolutions of Gold, as the ſulphureous one, which was diſcovered by Stahl, and publiſhed in his tract *de vitulo aureo* (*g*). Langelot contrived a machine, which he calls the philoſophic mill; in which Leaf-gold was ground with water to ſuch a degree of tenuity, as to paſs along with the water through the pores of a filter: This however is no true ſolution, the Gold being here barely divided into minute atoms, which on ſtanding ſubſide again from the water by their own gravity. When Gold is triturated for a length of time in a glaſs-mortar, a little vitreſcible matter is obtained: This does not proceed, as ſome have ſuppoſed, from the Gold, but from a portion of the matter of the Glaſs rubbed off in the grinding.

ſoluble by Sulphur,

Much has been talked of inſipid menſtrua for Gold. Hoffman looks upon all theſe, as matter of fiction, or of fraud; and queſtions the exiſtence of any ſubject in nature, from which ſuch a menſtruum could be prepared. Thus much however is certain, that if Gold be put into a receiver with ſome plain water; and a Glaſs body, containing a certain liquor, be fitted with a head joined to the receiver; and the whole ſuffered to ſtand in the cold, the Gold will by degrees, imperceptibly diſſolve in the water. Kunckel relates, that Gold may

inſipid Menſtrua for Gold.

Reputed Menſtrua.

(*f*) *Kunckel's method of diſſolving Gold.*] By this method, a much ſmaller quantity of the menſtruum proves ſufficient, than if the Sal Ammoniac was previouſly diſſolved in the Aqua fortis; the conflict, which each addition of the Salt raiſes with the Acid, greatly promoting the diſſolution of the Gold. Aqua fortis of moderate ſtrength will thus take up about one third its weight of Gold; whereas an Aqua Regis, ready prepared from the ſame Aqua fortis, will not diſſolve above one fifth its weight. Sea-Salt, managed in the ſame manner, anſwers better than Sal Ammoniac.

(*g*) *Stahl's ſulphureous ſolution of Gold.*] Gold is not acted upon in the leaſt by pure Sulphur; which ſcorifies or diſſolves in fuſion every other metallic body except Zinc and Platina. But if the Sulphur be previouſly melted with an equal quantity of fixed alcaline Salt; this compound, melted with Gold, readily unites with it into an uniform maſs, which diſſolves in water without any ſeparation of the Gold. The author above mentioned endeavours to prove, that ſulphurated Alcali was the medium by which Moſes calcined the golden calf ſo as to be miſcible with water. The ſolution, beſides a nauſeous taſte from the Sulphur, has a peculiar penetrating bitterneſs, not diſcoverable in any other metallic ſolution made by the ſame means.

Though the compoſitions of Sulphur and Alcali ſeem to unite more intimately with Gold than with other metals, their affinity with it is but ſlight: Copper or Iron, added to the matter in fuſion, diſunite and precipitate the Gold. The Gold, thus recovered, and purified by the common proceſſes, proves remarkably paler coloured than at firſt. In an experiment related by Dr. Brandt in the Swediſh Memoirs, the purified Gold turned out nearly as pale as Silver, without any diminution of its weight.

GOLD. may be diſſolved by placing it in a receiver with Spirit of Wine, and driving over Spirit of Nitre upon it; or by putting the Gold into Spirit of Salt, and adding ſome drops of Spirit of Urine. Neither of theſe experiments ſucceeded with me; though Kunckel rarely advances any thing as fact, that is not really ſo (*b*).

Aurum Fulminans. From the ſolution of Gold in Aqua Regis is prepared the clay-like Precipitate, called from its exploſive power *Aurum Fulminans*. The ſolution is diluted with water; and either a fixt alcaline Lixivium, or a volatile alcaline Spirit, gradually added, or the fixt and volatile Alcali dropt in alternately, till the precipitation is completed. The Precipitate obtained by volatile Alcalies is in leſs quantity than by the fixed, but fulminates more ſtrongly (*i*). This preparation is to be dried with the utmoſt caution: It explodes from being barely ſet in a warm place, or moderately rubbed in a mortar, and its exploſion is extremely violent, ſo as to have been too often productive of terrible effects; of which examples may be ſeen in the *Ephemerides naturæ curioſorum*, and in the Breſlau Collections. It is commonly ſuppoſed to exert its action only downwards: But it acts equally in all directions, though its effect is moſt conſpicuous on the ſolid body upon which it is placed. The report is preceded by a flaſh, viſible in the dark; and during the exploſion, the Gold is revived into little granules, which may be caught by means of proper veſſels, as I ſhewed to ſeveral members of the Royal Society in London, and as Kunckel alſo has obſerved. The fulmination appears to proceed, not from the Gold, but from a ſubtile ammoniacal Nitre, or *Nitrum flammans*, compoſed of the nitrous Acid and volatile Alcali: A Precipitate made without volatile Alcali, either in the menſtruum or precipitant, will not fulminate: If to ſuch as does fulminate we add vitriolic Acid, which abſorbs the volatile Alcali from the nitrous, its fulminating quality will be deſtroyed: Saturated afreſh with volatile Alcali, it recovers its exploſive power. That Gold is not neceſſary to the fulmination, appears from the effect of the *pulvis fulminans* and other fulminating preparations in which there is no Gold.

Cauſe of its fulmination.

Some

(*b*) *Reputed Menſtrua for Gold.*] I have likewiſe tried theſe liquors, and the mixtures of vitriolic Acid with Salt of Tartar and with urinous Spirits, ſaid by the ſame author to be menſtrua for Gold; without ſucceſs. Mr. Pott informs us, in a paper in the Berlin Memoirs for the year 1752, that he obtained a ſpirit which diſſolved Gold, by diſtilling a ſolution of the ſecret Sal Ammoniac (that is, a neutral Salt compoſed of volatile Alcali and Oil of Vitriol) made in twice or thrice its quantity of Aqua fortis.

(*i*) *Precipitation of Gold by Alcalies.*] When fixed Alcalies are made uſe of, the Precipitate weighs about one fourth more than the Gold employed. With volatile Alcalies alſo, if they are cautiouſly added in no larger proportion than is ſufficient to ſaturate the Acid, the quantity of Precipitate proves nearly the ſame: But if the volatile Spirit is added in an over-proportion, it rediſſolves a part of the Gold which it had before precipitated, and the liquor becomes again conſiderably yellow. I could not, however, by any addition of the ſpirit, procure a total rediſſolution of the Gold, though both the animal oily Spirits, and that of Sal Ammoniac, prepared both with Salt of Tartar and with Quick-lime, were made trial of: Nor did either of theſe ſpirits ſenſibly diſſolve, or extract any tinge from precipitates of Gold which had been thoroughly edulcorated with boiling water.

Some prepare their Aurum Fulminans [of a purple colour] by evaporating the ſolution of Gold to dryneſs, diſſolving the dry matter in freſh Aqua Regia, inſpiſſating the liquor again, and repeating this procedure a ſecond and a third time: The ſolution is at laſt evaporated to the conſiſtence of Oil, and then precipitated with Oil of Tartar per deliquium. This method is not to be approved; as we can ſeldom, from ſuch thick liquors, obtain a complete precipitation.

Precipitations of Gold.

Solution of Gold may be precipitated by ſundry ſubſtances beſides Alcalies; as Quick-ſilver, ſolution of Quick-ſilver, ſolution of Vitriol, ſolution of Verdigris, Tin, &c. (*k*)—Solution of Tin, dropt into a ſolution of Gold largely diluted with water, or Tin itſelf added to the diluted liquor, changes its yellow colour to a fine purpliſh red (*l*). By this mark, minute portions of Gold may be diſcovered in liquors. The Precipitate, which ſubſides on ſtanding, is likewiſe of a purpliſh red; and, melted with a large proportion of fritt or colourleſs Glaſs, tinges it of a beautiful red colour: Kunckel obſerves, that one part of Gold is ſufficient to communicate a ruby red to twelve hundred and eighty parts of Glaſs, and a ſenſible redneſs to nineteen hundred and twenty (*m*). If ſolution of Gold made in Aqua Regis be evaporated a little, ſome rectified Spirt of Wine added, and the whole ſuffered to remain quiet, the Gold will ſhoot into Cryſtals.

Ruby Glaſs.

Cryſtals of Gold.

Gold

(*k*) *Precipitation of Gold by metallic ſubſtances.*] All the metallic bodies which diſſolve in Aqua Regia, Platina excepted, precipitate Gold from it. Mercury and Copper throw down the Gold in its bright metallic form; the others, in that of a Calx or Powder which has no metallic aſpect.

Iron combined with the vitriolic Acid, that is Vitriol of Iron, though it continues a precipitant for Gold, precipitates no metallic body beſides; and hence we are furniſhed with a commodious method of purifying Gold from admixtures of all other metals. Kunckel directs Vitriol of Copper for this purpoſe, having probably made the experiment with a mixed Vitriol participating both of Copper and Iron, and attributed to one ingredient what was effected by the other: No Vitriol but that of Iron makes any precipitation in ſolution of Gold.

(*l*) *Purple or red with Tin.*] This phœnomenon ſucceeds with certainty when Tin in ſubſtance is uſed, provided the ſolution of Gold be largely diluted with water: With ſolution of Tin we cannot ſo eaſily ſecure ſucceſs, either in regard to the colour or precipitation—It is obſervable, that though the Gold is here precipitated by Tin from the diluted ſolution; yet if the whole be ſuffered to ſtand till the water has in great meaſure exhaled, the Gold is taken up afreſh, the liquor becomes yellow as at firſt, and only a white Calx of Tin remains.

(*m*) *Ruby Glaſs.*] The art of tinging Glaſs throughout of a ruby colour was diſcovered ſince the middle of the laſt century by Dr. Caſſius: The red glaſſes of earlier date are only ſuperficially painted. Kunckel was the firſt who brought the proceſs to any conſiderable perfection; and, as he informs us himſelf, prepared the Glaſs in large quantity, and vended it at a great price: He ſays he made a chalice of it for the elector of Cologn, of an uniform fine colour throughout, weighing no leſs than twenty-four pounds.

All that we can collect from his writings, relating to the proceſs, is, that he uſed for the tinging ingredient the Precipitate of Gold made with Tin; that this colours a large quantity of Glaſs, as above mentioned; that the proceſs does not conſtantly ſucceed; that oftentimes the Glaſs comes out of the pot colourleſs as Cryſtal, and receives

GOLD.

Of Gold as a medicine.

Gold has been imagined to be poſſeſſed of extraordinary medicinal virtues; and many preparations, dignified with the name of this precious metal, have been impoſed upon the public. But the virtues aſcribed to Gold have apparently no other foundation than credulity and ſuperſtition; and moſt of the golden medicines have no Gold in them: Even when Gold has been employed in the preparation, there is ſeldom any of it retained in the product. We may ſay with Ludovici, "It is better to make Gold out of medicines, "than medicines out of Gold."

Of extracting its tinging matter.

Some have pretended to extract the tinging matter of Gold, ſo as to leave the body of the metal white; miſled either by employing a menſtruum, which of itſelf acquired a colour during the digeſtion; or by finding at the bottom of the Glaſs, or on the ſurface of the Gold, a little white matter, which was no other than Silver previouſly contained in the Gold, or Regulus of Antimony with which the menſtruum had been impregnated: It was by uſing ſuch a menſtruum (the bezoardic Spirit of Nitre, as it is called) that Mr. Boyle was deceived (*n*).

Hoffman,

ceives its redneſs on being expoſed to a ſmoky flame; that Nitre or Sal Ammoniac, added to it in fuſion, call forth its latent colour; and that the colour thus extricated by the latter is the moſt beautiful, but quickly diſappears again upon continuing the fire. From the experiments of Orſchal, in a treatiſe entitled *Sol ſine veſte*, it appears, that other preparations of Gold, even the muddy matter obtained in poliſhing Gold with Pumice, anſwer equally with the Precipitate by Tin.

One Grummet, who had been an operator to Kunckel, publiſhed a tract in oppoſition to the foregoing, under the title of *Sol non ſine veſte*; in which he endeavours to prove, by experiments, that the Gold has no ſhare in the production of the colour, and that this proceeds wholly from Manganeſe employed in the compoſition of the glaſs. He affirms, that if white or Venice Glaſs (in the making of which, a proportion of Manganeſe is uſed, for promoting the tranſparency,) be reduced into powder, and melted with one fourth or one eighth of Nitre, it will acquire the true ruby colour; and that no addition of Nitre or of Gold will communicate any thing of that colour to a Glaſs made from Alcali and Flint without Magnaneſe.

Thus much is certain, that Glaſs may be tinged of a fine red colour by means of Manganeſe; that this colour totally diſappears upon a continuance of the fuſion; and may be again brought back by an addition of Nitre.

In regard to Gold, with its calx precipitated by Tin I have, in the glaſs-houſe furnace, tinged common white Glaſs of a true ruby red. With fritts compoſed of calcined Flint and alcaline Salt or Borax, melted with the ſame calx in a wind furnace, the colour did not equally ſucceed, though the proceſs was upwards of twenty times repeated and varied; and Sal Ammoniac, Nitre, and ſmoky flames, were called in aid: The Glaſs proved commonly yellowiſh, with violet-coloured veins: Sometimes there were ruby-coloured ſpecks, and generally a button of revived Gold at the bottom.

(*n*) *Boyle's white metal from Gold.*] Mr. Boyle relates, that on diſſolving fine Gold in an Aqua regia diſtilled from Butter of Antimony and Aqua fortis, a conſiderable quantity of white powder remained undiſſolved: That the Gold, being reduced into a body, yielded on a ſecond ſolution more of this powder, but in leſs quantity than the firſt time: That with common good Aqua regia, he could obtain, from the very beſt Gold, ſome little quantity of the like white powder: And that theſe powders, melted with Borax, gave a white malleable metal, whoſe appearance, ſolubility in Aqua fortis, and odious bitterneſs when diſſolved, ſhewed to be true Silver.

We

Hoffman, the elder Geoffroy and others, prepare tinctures of Gold by Spirit of Wine and eſſential Oils, from a ſolution of the metal made in Aqua Regis: Some take the *Oleum vini*, or a well made *Spiritus vitrioli dulcis:* But all theſe preparations receive their virtues from the additional matters, and not from the Gold. It is obſervable, however, that Oil of Juniper-berries, and perhaps other eſſential Oils, mixed with a ſolution of Gold in Aqua Regis, take up the Gold from the Acid, and acquire commonly a blackiſh colour on the upper ſurface, and a Gold-yellow one underneath (*o*): If this mixture is ſet to digeſt, we muſt be cautious in regard to the fire, for it is apt to grow ſuddenly hot, and at once run over the veſſel. Hoffman ſays, how juſtly I pretend not to determine, that the beſt preparation of Gold for medicinal uſe, is a mixture of two parts of martial Regulus of Antimony and one of Gold melted together, and calcined in a glaſs phial till they are changed into a purple crocus.

GOLD. Tinctures. Gold taken up from Aqua Regis by Oils.

The largeſt quantities of Gold are met with in the Spaniſh Weſt Indies: There are mines of it alſo in ſome parts of Europe, particulary in Hungary and Tranſylvania. It is either imbedded in flinty or other ſtones, or intermingled among the looſe earth; always in its metallic form, though the particles are commonly very ſmall and often indiſtinguiſhable (*p*). It is never found in the ſtate of a true ore, unleſs when blended with a large proportion of

Natural hiſtory of Gold.

We cannot ſuppoſe, as ſome have done, that this metal proceeded from an antimonial Regulus contained in the menſtruum; any more than, with Mr. Boyle, that it was a part of the Gold actually tranſmuted into Silver. It is by quartation with Silver (ſee page 43.) that Gold is commonly refined; and in that proceſs it always retains a portion of the Silver, ſeparable by Aqua Regia. When Aqua Regia is made with an under proportion of marine Acid, it diſſolves a little Silver along with Gold; and hence probably the Silver obtained on the ſecond diſſolution.

(*o*) *Gold taken up from Aqua Regia by eſſential Oils.*] The Gold, thus imbibed by Oils, does not long remain diſſolved in them; in a few hours it ſeparates, in bright yellow films, to the ſides of the Glaſs—The ſubtile oily fluid called Æther or æthereal Spirit of Wine, takes up the Gold more readily and perfectly than the common Oils, and keeps it permanently diſſolved, the acid liquor underneath appearing colourleſs: The yellow æthereal ſolution, careſully poured off, and kept for ſome time in a glaſs ſtopt with cork ſo as that the ſpirit may ſlowly exhale, yields long, priſmatic, tranſparent Cryſtals, in ſhape like thoſe of Nitre, in colour yellow like Topaz——Rectified Spirit of Wine mingles uniformly with the ſolution of Gold made in acids: If the mixture is ſuffered to ſtand for ſome days in a glaſs ſlightly covered, the Gold is by degrees revived, and ariſes in bright pellicles to the ſurface—Groſſer inflammable matters, Wine, Vinegar, Solutions of Tartar, throw down the Gold, in its metallic form, to the bottom——Gold is the only metallic body which is thus ſeparable from its ſolutions in Acids by either of theſe ſubſtances: And hence Gold may by theſe means be puriſied from all admixtures, and ſmall proportions of it in liquors readily diſcovered.

(*p*) *Gold in Stones, Ores,* &c.] There are two general methods of extracting Gold from its ore or matrix; amalgamation and fuſion.

1. When the Gold is ſuperficially embedded in earths or ſtones, in its metallic form; the mineral is reduced into powder, the lighter earthy parts ſeparated by ablution with water, and the remainder triturated with a quantity of Quickſilver; which imbibes or amalgamates with the Gold, whilſt the earthy and ſtony matters

GOLD. of other metals: The Gold Ore of Rammelſberg in Goſlar holds only a few grains on an hundred weight. Some Gold is alſo met with in ſundry rivers, as the Tagus, the Ganges, the Rhine, the Saale, the Niger, the Danube, and many others, commonly in fine duſt, often in flat moleculæ, ſometimes ſuſpended by the water in inviſible atoms, which ſettle upon ſtanding, and are diſtinguiſhed by the name of river or waſh Gold: Theſe golden particles doubtleſs

float on the ſurface and are eaſily waſhed off: The waſhed Amalgam being committed to diſtillation, the Mercury ariſes, and the Gold is left behind. This is the method by which Gold and Silver are extracted from their ores in the Spaniſh Weſt-Indies.

2. When the Gold is too intimately combined in the compoſition of the ore, to be ſeparable by Quickſilver; the mineral is brought into fuſion by fire. If the quantity of Gold was very conſiderable, it would ſubſide from the fluid matter by its own gravity, by whatever means the fuſion was procured: But in ores, the Gold is in too ſmall proportion, its particles too minute and too widely diffuſed, to ſeparate in this manner, without the addition of ſome other metallic body to imbibe and collect it. The addition commonly made uſe of is Lead; this metal eaſily vitrifying in the fire; and, when vitrified, powerfully promoting the vitrification or fuſion of earthy or ſtony matters; at the ſame time that the part which remains unvitrified imbibes the Gold and carries it to the bottom. Biſmuth anſwers the ſame end, rather more effectually; its Glaſs being ſomewhat more active as a flux than that of Lead, in regard both to the facility and tenuity of the fuſion. The Gold thus transferred into Lead or Biſmuth is ſeparated by keeping the mixture in fuſion upon a cupel or teſt: The cupel is a ſmall ſhallow veſſel made of bone-aſh, which abſorbs the Lead or Biſmuth in proportion as they vitrify: The teſt is a large oval hearth, on which the Lead, as it vitrifies and ariſes to the ſurface, is raked off from the Gold, or blown off by bellows.

Minerals containing Gold intimately blended in their compoſition are frequent in moſt parts of the world. Many of our common ſands are perhaps richer in this metal than the ores of Peru; though they yield it with ſuch difficulty, that it is ſcarce to be extracted from them to any advantage. The yellow, red, black, ferrugineous ſands are the richeſt, but at the ſame time the moſt refractory; the matter being not only very hard of fuſion, but the Gold ſtrongly retained, and defended from the action of Lead, by the ferrugineous part. Becher formed great expectations from ſome experiments on the more fuſible Sands; which, though they hold leſs Gold, yield it with more eaſe.

Mr. Hellot informs us, (in his French verſion of Schluter) that in eleven eſſays of the ſame ferrugineous ſand, made by Mr. Leberecht, the proportion of noble metal turned out conſtantly from eight hundred and forty to eight hundred and forty-four grains on the quintal or hundred pounds; and that from one fourth to one third of this was Gold, and the reſt Silver. He obſerves that different parcels of ſand, taken up at no great diſtance from one another, differ in degree of richneſs; ſome having yielded above a thouſand grains on the quintal, others only three hundred and fifty, and others again containing nothing but Iron. Theſe eſſays were made, by mixing the ſand (previouſly four times calcined, and as often quenched, whilſt red-hot, in water) with twice its weight of granulated Lead, and equal its weight of black flux, ſpreading ſome common ſalt on the ſurface, and melting them, with a fire ſtrongly excited in a blaſt-furnace, till the ſcoriæ flowed thin as water, ſo as not to adhere to the iron-rod with which the matter was from time to time ſtirred.

The precious metal may be extracted alſo, and perhaps more perfectly, by vitrifying the ſand with Glaſs of Lead, and afterwards reviving the Lead. Sulphur, added to the vitreous compound, readily unites, and changes it into a ſparkling maſs, of a ſemimetallic aſpect, ſimilar in quality to the natural Lead Ores which participate of Gold and Silver, and yielding its metallic contents by the ſame treatment.

doubtleſs proceed from ſome mines or veins of Gold; from which the metal has been waſhed out, and carried down by the ſtream. Some have pretended to find perfect Gold in vegetables, particularly in the vine-tree; but on examining thoſe Gold-like ſpecks or granules, by fire, by Quickſilver, or other trials, they ſoon diſcover themſelves to be no Gold.

Its alloy.

Gold coins and utenſils are not made of pure Gold, but have always an alloy of Silver, or Copper, or both together, by which the Gold is rendered firmer, harder, and more ſonorous (*q*). When Gold is perfectly pure, it is called *Gold of twenty-four carats*; the meaning of which is, that in an ounce of the metal all the twenty-four ſcruples are pure Gold. If only twenty-three ſcruples are fine Gold, and the other ſcruple a baſer metal, it is called Gold of *twenty-three carats*; and in general, the number of carats by which the fineneſs is expreſſed, denotes the number of ſcruples of fine Gold in an ounce or twenty-four ſcruples of the mixt. The ancients ſuppoſed the Gold of different countries to differ in quality; the Armenian to be the beſt, the Hungarian next to it, and the Rheniſh the worſt. But Gold, when perfectly pure, is always one and the ſame, where-ever it is to be found; no other differences being obſerved in it than what proceed from an admixture of ſome other metal.

purification from the baſe metals.

There are different methods of ſeparating Gold from admixtures of other metals. If only a baſe metal is mixed with Gold, they may be ſeparated by teſting or cupellation with Lead; the baſe metal vitrifying with the Lead, whilſt the Gold remains unhurt (*r*).

Method of parting Gold and Silver.

Silver, which reſiſts the deſtructive power of Lead equally with Gold itſelf, is ſeparated by acid menſtrua. For this purpoſe, we muſt firſt examine, whether the mixture contains moſt Gold, or moſt Silver: If the Gold is found to prevail, the metal is to be flatted into plates, or granulated, and put into a proportionable quantity of Aqua regis, which diſſolves the Gold, and leaves the Silver in the form of powder at the bottom: The Silver, waſhed and dried, may be melted into a maſs, with the addition of a little Tallow, and ſome Nitre or Borax; and the Gold may be recovered from the liquor by precipitation

(*q*) *Alloy.*] Standard Gold contains one twelfth its weight of alloy, moſt commonly of Copper; this metal not weakening the colour as Silver does, but rather heightening it: It is ſuppoſed alſo, perhaps on no very good foundation, that Copper preſerves the malleability of Gold in certain circumſtances wherein pure Gold would become brittle. The ſpecific gravity of this compound is leſs than the mean gravity of the Gold and Copper unmixed.

(*r*) *Cupellation with Lead.*] Gold is not ſo perfectly purified by this proceſs as has been commonly ſuppoſed. It almoſt always retains a portion of the Lead itſelf, ſmall indeed, but ſufficient to render it brittle: From this it is purified by injecting upon it in fuſion a little Mercury-ſublimate; the acid of the ſublimate corroding the Lead, which now ariſes in ſcoriæ round the ſides of the veſſel, no longer miſcible with the Gold——Nor is Gold to be perfectly purified by cupellation from Copper: It attracts this metal more ſtrongly than it does Lead. If pure Gold be mixed with about one twenty-fourth its weight of Copper, it will ſuffer Lead almoſt totally to work off, but retain nearly all the Copper——The admixture of Silver varies its affinity to both theſe metals. Mixed with a little Silver, it parts with Copper, and not with Lead: Mixed with an equal quantity, it parts with both.

GOLD. cipitation. If on the other hand, the quantity of Silver is much greater than that of the Gold, Aqua fortis is made uſe of, which diſſolves the Silver, and leaves the Gold behind, in form of a black maſs or powder to be waſhed and melted with Borax. If the proportions of the two metals are nearly equal, the mixture is melted with ſo much freſh Silver, as will make the whole quantity of Silver at leaſt three times greater than that of the Gold: If the quantity of Silver is much leſs than this, the beſt Aqua fortis will not be able to extract it from the Gold: If much greater, the ſolution or extraction will go on the faſter, but the Gold will remain in form of powder, ſome particles of which may be in danger of being loſt: If it is juſt thrice the weight of the Gold, the Gold retains the form of the original plates: From the Gold making one fourth of the compound, the proceſs is commonly called *quartation.* This method of parting the two metals is more commodious and effectual than that by Aqua regis; Aqua fortis diſſolving the Silver much ſooner than Aqua regis does the Gold; and the former taking up none of the Gold along with the Silver, whereas the latter almoſt always diſſolves a part of the Silver along with the Gold, eſpecially if the Aqua regis is made with an under-proportion of marine Acid.

Cementation. Gold is likewiſe purified from Silver by Acids applied in the form of vapour free from phlegm. Thus applied, they extract ſmall proportions of Silver as well as large ones; the Gold being unable to defend that metal againſt the fumes, as it does againſt the Acid in its liquid ſtate. The marine vapours alſo, in this method of application, corrode the Silver as effectually as the nitrous: The only difference is, that when corroded by the nitrous, ſuch part as may remain in the pores of the Gold is eaſily diſſolved and waſhed out by water, whereas with the marine, it forms a concrete not diſſoluble in water——The method of performing the proceſs is this. Nitre, or common Salt, (not both at once, for the vapour ariſing from the mixture would diſſolve the Gold as well as the Silver) is mixed with an equal quantity of calcined Vitriol, by which its Acid is extricated in the fire; and twice its weight of powdered Bricks, to prevent the matter from melting and adhering to the ſurface of the metal. The Gold impregnated with Silver, is flatted into plates; cleanſed by ignition from any external unctuoſity that might impede the action of the acid; then ſtratified and every where ſurrounded with the mixture in a crucible or cementing-pot; the veſſel cloſely covered and luted; the fire gradually raiſed to a ſlight red heat, and kept up for twelve, ſixteen or twenty hours——It is often neceſſary to repeat the cementation; a part of the Silver being apt to eſcape the action of the fumes, eſpecially when the plates are of conſiderable thickneſs: The metal, after one cementation, muſt be melted and laminated afreſh, before it is committed to another. Theſe kinds of operations were formerly often practiſed; but have now in great meaſure given place to more advantageous and effectual methods of ſeparation. The mixture with Sea-Salt is commonly called the *regal* cement; Gold being the only metallic body [Platina excepted] that is capable of reſiſting it.

Method of diſtinguiſhing Gold from metals that reſemble it in colour. The reſiſtance of Gold to Aqua fortis affords a ready method of diſtinguiſhing that metal from compoſitions reſembling it in colour. If a line be drawn with the maſs, upon any ſmooth ſtone that does not diſſolve in acids, a drop

of

of Aqua fortis will take off the mark left by any of the baſe metals, whilſt that made by Gold remains untouched. GOLD.

If Gold contains Copper, Lead, or other imperfect metallic bodies, along with Silver, it is purified firſt from the baſe metal by the teſt or cupel, and then ſeparated from the Silver by quartation——It is purified alſo from all the metals by fuſion with Antimony, which abſorbs or ſcorifies all but Gold. Tin is moſt commodiouſly ſeparated by injecting corroſive Sublimate upon the Gold in fuſion. Mercury is diſſipated from it by bare ignition.

Gold is cleanſed from external impurities, by heating it red-hot, and waſhing it with weak Aqua fortis, brine of Sea-Salt with Tartar, *&c.* When pale, the colour, is heightened, by melting it with Copper and afterwards ſeparating the Copper; or by a mixture of Verdigris and Sal Ammoniac with Vitriol or Nitre (*s*). Some boil the pale Gold in a ſolution of theſe Salts made in Vinegar: Others moiſten the Salts with Vinegar into the conſiſtence of a paſte, which is ſpread upon the Gold, and the metal laid upon burning coals till the mixture is burnt off. The ſprinkling of the Salts in powder upon the moiſtened Gold, practiſed by ſome, does not anſwer ſo well. It is ſaid that a mixture of Gold with one third, or even with half its weight of Silver, acquires, on cementation with Verdigris, the colour of pure Gold. The Silver however is eaſily diſcovered on the touchſtone by means of Aqua fortis: If a line be drawn with the compound metal, a little Aqua fortis, applied upon the part, will eat out the Silver; and the remaining Gold will appear ſpecked and diſunited (*t*). Methods of cleanſing it externally, and heightening its colour.

II. SIL-

(*s*) *Colour heightened.*] The colour of Gold is improved alſo by fuſion with Nitre; injecting Sal Ammoniac upon it in fuſion; quenching it in urine; boiling it in a ſolution of Alum. When Borax is uſed as a flux, it is cuſtomary to add a little Nitre or Sal Ammoniac, to preſerve it from being made pale by the Borax——Juncker reports, from the *Alchymia depudata*, that by melting Gold with four times its weight of Copper, ſeparating the Copper by Aqua fortis unpurified, then melting the Gold with the ſame quantity of freſh Copper, and repeating this proceſs eight or nine times; the Gold becomes at length of a deep red *puniceous* colour, which ſuſtains the action of Lead, Antimony and Aqua fortis.

(*t*) *Additional article: PLATINA.*] This metal, ſaid to be found in the Gold-mines of the Spaniſh Weſt-Indies, has but lately become known to Europe. In what form it is met with in the mines, we have no ſatisfactory account: To us, it is brought over in ſmall white grains, mixed with a ferrugineous Sand and ſome other foreign matters. It is called by the Spaniards *Platina* (a diminutive of *Plata*, Silver) probably from its colour; for in this reſpect it greatly reſembles Silver, though in others it comes nearer to Gold.

It poſſeſſes, in effect, almoſt all thoſe properties, which have been hitherto ſuppoſed characteriſtic of Gold, and ſtands all the teſts by which that metal has been uſually aſſayed or refined; being nearly as ponderous; equally diſſoluble in Aqua regia, and precipitable by the other metals which diſſolve in that menſtruum; equally reſiſting Aqua fortis, and the other ſimple Acids, and the regal cement; being equally permanent and fixed in the fire; equally indeſtructible by Lead and by Biſmuth; unaffected by Nitre and by Sulphur; incapable of being ſcorified by the ſulphureous part of Antimony, or volatilized by its reguline.

Theſe properties, together with the place where it is found, and the prohibition ſaid to be laid upon its exportation by the king

PLATINA. of Spain, afford ſufficient grounds to preſume that the *Smiris Hiſpanica* of the alchemiſts, employed for augmenting Gold, was no other than this Platina or ſome mineral containing it; more eſpecially as Becher expreſsly declares, that this augmentation was really an abuſe; that the Gold ſo augmented was pale and brittle; and that though it ſtood all the eſtabliſhed teſts of perfect Gold, yet it would not bear amalgamation with Quickſilver, the Mercury retaining the Gold, and throwing out the *Smiris* in form of a reddiſh powder. Platina mixed with Gold is thrown out in the ſame manner; though it is not eaſy by this method to obtain a perfect ſeparation.

This metal is in ſome ſmall degree malleable; leſs ſo when ignited than when cold. Its ſpecific gravity is to that of Gold, nearly as 18 to 19. The grains cohere in a ſtrong fire, but do not melt, or ſoften, or ſenſibly alter their figure; whether expoſed to its action in cloſe veſſels, or placed in contact with the burning fuel; by themſelves, or with the addition of inflammable, ſaline, vitreous or earthy fluxes. Compoſitions of Sulphur and fixed alcaline Salts, render it fuſible in the fire, and ſoluble in water.

Platina melts perfectly with all the metals, and occaſions remarkable alterations in their colour, texture and hardneſs. It deſtroys the malleability of near four times its weight of Tin: With larger proportions, it forms compounds tolerably ductile, but renders the texture of the Tin coarſer, and debaſes its colour. All theſe compoſitions tarniſh in the air; thoſe leaſt, which have either a very ſmall or a very large proportion of Platina.

A ſmall quantity is taken up very eaſily by Lead: A large one is taken up much more difficultly than by Tin, and ſubſides in great part upon an abatement of the heat. A little quantity ſtiffens and hardens Lead much more than it does Tin; but a large one does not near ſo much diminiſh its malleability. A leafy or fibrous texture, a purpliſh or blue colour, or a diſpoſition to quickly acquire this colour from the air, are peculiar to the mixtures with Lead.

It unites with Silver more difficultly than with either of the two foregoing, and is more apt to ſubſide from it on an abatement of the fire: A part of the Silver is likewiſe thrown up during the fuſion, and adheres to the cover of the crucible in little globules: To this, of all the metals, it diſcovers the greateſt repugnance. It diminiſhes the malleability of Silver far leſs than that of Lead or Tin, and does not, in whatever proportion employed, ſo much debaſe its colour or diſpoſe it to tarniſh.

It diminiſhes the ductility of Gold far leſs than that of any other metal: A mixture even of equal parts of each may, with proper care, be ſomewhat flattened by the hammer. In conſiderable proportions, it debaſes the colour more than the uſual alloy, not communicating its own whiteneſs, as the other white metals do, but a peculiar dingy hue, readily diſtinguiſhable by the eye. In ſmall proportions, as one fiftieth, it does not ſenſibly injure either the colour or malleability of Gold.

A large proportion whitens Copper, and renders it very hard and brittle: A ſmall one improves its hardneſs, without ſeeming to injure its colour, or, ſo far as could be judged, its malleability. Theſe mixtures bear a fine poliſh; and do not tarniſh in the air, ſo much, or ſo ſoon, as pure Copper.

It renders caſt Iron exceſſively hard, in ſome degree tough, ſuſceptible of a fine poliſh, and not apt to tarniſh. The compound, cemented with the Steel-making mixtures, is not changed into Steel; but ſomewhat ſoftened, and more ſo than by the ſubſtances which ſoften pure caſt Iron.

It unites with Biſmuth, Zinc, and Regulus of Antimony, as perfectly as with the malleable metals. It increaſes the hardneſs of the two latter, but not of the former; diſpoſes Biſmuth to change its colour in the air, but not the other two.

Its effects on the compound metals are ſimilar to thoſe which it produces on the ſimple ones. Braſs, it renders white, hard, brittle, ſuſceptible of a fine poliſh, and not liable to tarniſh; as it does the Copper, and in ſome degree the Zinc, of which that metal is compoſed. Mixtures of it with Copper and Tin are more apt to tarniſh than thoſe with Copper only, and leſs than thoſe with Tin only.

All the compoſitions of Platina with metals are more brittle when ignited than when cold. Their ſpecific gravity is leſs than

than the medium of the gravities of the two ingredients. All the metals may be made to take up equal their own weight of the Platina; ſome metallic compoſitions of Tin, Copper, &c. twice their weight. Several of the mixtures melt, and appear uniform to the eye, by a moderate heat; but the union is never perfect without a ſtrong one.

After Platina has thus been brought into fuſion by metallic additions, it proves, on ſeparating the metal, as refractory as at firſt. In cupellation with Lead, as ſoon as the Lead has been worked off to a certain point, the matter becomes conſiſtent, and can no longer be made to melt, or to part with any more of the Lead. The caſe is the ſame in ſcorifying Biſmuth from it, or diſſipating regulus of Antimony or Zinc; the Platina at length refuſing to melt, and defending a part of thoſe deſtructible metals from the action of the fire and air. Platina cupelled with Lead, unleſs the button turns out ſpongy, is found to be remarkably more ponderous than at firſt, notwithſtanding its retaining a conſiderable portion of that lighter metal: The ſpecific gravity of ſome of the neater and more ſolid beads, was very nearly the ſame with that of fine Gold.

Platina diſſolves in Aqua regis, very ſlowly and difficultly, into a dark browniſh red liquor; a few drops of which tinge a large quantity of water of a fine golden colour. The ſolution, duly evaporated, ſhoots into deep yellowiſh-red Cryſtals. It gives no ſtain to hot Marble, or to the ſkin, bones, or other ſolid parts of animals. Oil of Vitriol, added to the concentrated ſolution, precipitates the Platina; but makes no change if the liquor is previouſly diluted. The Platina is precipitated by alcalies, and by Sal Ammoniac, in form of a red powder: This, expoſed to the fire, becomes blackiſh, without fulminating; waſhed with water, it acquires a ſimilar colour, tinging a large quantity of the fluid of a golden hue. None of the ſubſtances that have been tried occaſion, ſingly, a complete precipitation; a part of the Platina remaining always diſſolved. By alternate additions of alcalies, and Sal Ammoniac, or by adding Tin after either of theſe, the whole is thrown down, and the liquor left colourleſs. Volatile alcalies, added after the precipitation is completed, rediſſolve a part of the Platina; and more than they do of Gold by the ſame treatment. The precipitates, thoroughly edulcorated by boiling water, diſſolve in ſpirit of Salt; much more difficultly and ſparingly than thoſe of Gold. The precipitates made both with metallic and ſaline ſubſtances, reſiſt vitrification. PLATINA.

Solution of Platina does not ſtrike a purple colour with Tin; nor prevent Gold, mixed with it, from ſtriking this colour. The Platina is not revived from its ſolution by inflammable ſpirits, nor taken up by eſſential Oils or Æther; and does not prevent Gold from being revived by the former, or taken up by the two latter. It is not precipitated by ſolution of green Vitriol, nor prevents Gold from being precipitated by that Salt——Theſe experiments afford ready means of diſtinguiſhing ſmall proportions of Platina mixed with Gold, or of Gold mixed with Platina; and of perfectly purifying or ſeparating the two metals from one another.

A more particular account of the principal experiments I have hitherto made on this extraordinary metal, may be ſeen in the *Philoſophical Tranſactions* for the years 1754, and 1757, from whence the foregoing general reſults are extracted. Mr. Scheffer has likewiſe given ſome curious experiments on this metal, which he calls white Gold, in the *Kongl. Suenſka vetenſkaps academiens handlingar*. The very ſmall quantity of Platina, which he was furniſhed with, did not permit his carrying theſe experiments to any conſiderable length: So far as they go, they agree ſufficiently with mine, except in regard to the effect of Arſenic. He reports, that Platina, ſtrongly heated, melts in an inſtant upon the contact of a very ſmall proportion of white Arſenic. I have treated Platina and Arſenic in different ways, with and without inflammable additions, by the moſt intenſe fires I was able to excite, without ever obſerving it become fluid. There was commonly a tendency to fuſion on the ſurface, which appeared in part ſmooth, bright, and united: But the internal part of the maſs was conſtantly found to conſiſt of unchanged grains of Platina. It was the ſmallneſs of the quantity, which prevented Mr. Scheffer from obſerving, that the fuſion was only apparent and ſuperficial.

II. SIL-

II. SILVER.

SILVER. SILVER (the *Luna*, *Diana*, *Proſerpina*, *Regina metallorum*, of the Chemiſts,) is the moſt perfect, ductile, and fixed in the fire, of all metals after Gold (*u*). A ſingle grain has been drawn into a wire three yards in length; and the wire flatted into a plate an inch broad. In common fires, it ſuffers no diminution of its weight; and kept in the vehement heat of a glaſs-houſe furnace for a month, it loſes no more than one ſixty-fourth. In the focus of Tſchirnhaus's large burning-glaſs, it ſmokes for a long while, then contracts a greyiſh aſh on the ſurface, and at length is totally diſſipated.

Its general properties, ductility, fixity; expoſed to a burning-glaſs.

The proper menſtruum of Silver is the nitrous acid; which, if well dephlegmated, will diſſolve equal its own weight: The ſolution ſtains the ſkin black (*x*). Some have thought to increaſe the ſtrength of the acid, by drawing it over from a quantity of freſh Nitre; and been ſurprized to find, that inſtead of acting more powerfully upon Silver, it would not now diſſolve that metal at all, only corroding it into a white powder; and that on the other hand, it now proved a menſtruum for Gold, which before it had no effect upon.

Solution in the nitrous Acid.

(*u*) *Silver.*] Silver is a ſoft, flexible metal, of little or no elaſticity: By hammering it becomes moderately hard, elaſtic and ſonorous; more ſo than Gold, leſs than Copper or Iron. Its ſpecific gravity is to that of water nearly as $10\frac{3}{4}$ to 1. It melts in a bright red heat, a little ſooner than Gold; and when in fuſion, appears a perfect ſpeculum. Like Gold, it continues ductile when heated as well as when cold; loſes a little of its ductility by ſudden cooling; proves brittle when heated by hammering; and regains its priſtine malleability on being nealed, that is, ſlightly ignited and ſuffered to cool very leiſurely. It ſeems to be perfectly fixed in the greateſt degree of culinary fire; the ſmall diminution, which in ſome experiments of this kind has happened at firſt, being apparently not of the Silver itſelf, but of ſome other metal with which it had been debaſed.

(*x*) *Solution ſtains*, &c.] It ſtains hair, bones, and other ſolid parts of animals, and different kinds of wood, of all the intermediate ſhades, from a light brown to a deep and laſting black. The liquors commonly ſold for ſtaining hair brown or black, are no other than ſolutions of Silver in Aqua fortis, ſo far diluted with water as not ſenſibly to corrode the hair.

It gives a permanent ſtain likewiſe to ſundry ſtones; not only to thoſe of the ſofter kind, as Marble: but to ſome of conſiderable hardneſs, as Agates and Jaſpers. The ſolution, for this purpoſe, ſhould be fully ſaturated with the metal; and the ſtone, after the liquor has been applied, expoſed for ſome time to the ſun. Mr. du Fay obſerves (in a paper upon this ſubject in the French Memoirs for the year 1728) that if the ſolution be repeatedly applied, it will penetrate, in the whitiſh Agate or chalcedony, about one twelfth of an inch: That the tincture does not prove uniform, on account of veins in the ſtone: That the colours thus communicated by art are readily diſtinguiſhable from the natural, by their diſappearing upon laying the ſtone for a night in Aqua fortis; that on expoſing it afterwards to the ſun for ſome days, the colour returns: That the ſolution gave ſomewhat different tinctures to different ſtones; to the oriental Agate a deeper black than to the common Chalcedony; to an Agate ſpotted yellow, a purple; to the Jade-ſtone, a pale browniſh; to the common Emerald, an opake black; to common Granate, a violet unequally deep; to Serpentine-ſtone, an olive; to Marble, a reddiſh, which changed to a purple, and fixed in a brown: That on Slates, Talcs, and Amianthus, it had no effect.

upon. Theſe alterations depend wholly upon the Nitre containing Sea Salt; whoſe Acid is expelled in the diſtillation by a part of the nitrous, and forced over along with the reſt: Pure Spirit of Nitre, drawn over from pure freſh Nitre, diſſolves Silver, and leaves Gold untouched, as at firſt. SILVER.

Solution of Silver, evaporated a little, ſhoots in the cold into Cryſtals (*y*), intenſely bitter and corroſive, and hence called by ſome *fel metallorum*, the gall of metals: The cryſtallization is promoted by dropping in a little Spirit of Wine before the liquor is ſet to ſhoot. The cryſtals, or the ſolution inſpiſſated to dryneſs, melt in a ſmall heat, and form on cooling a dark coloured maſs ſtill more corroſive, their phlegm having been diſſipated in the fire. This maſs is the lunar Cauſtic or infernal Stone of the ſhops: For the greater conveniency of uſing it as a Cauſtic, it is commonly caſt, in proper moulds, into ſlender cylindrical pieces. The Cryſtals have been given internally, as purgatives and diuretics, and hence named *Catharticum lunare*, and *hydragogum Angeli Salæ:* They are a medicine of great activity, too great to be taken with ſafety. Cryſtals. Lunar Cauſtic.

If ſolution of Silver be diluted with pure water, a conſiderable quantity of pure Mercury added, and the whole ſet by in a cold place; there will form by degrees a precipitation and cryſtallization reſembling a little tree, with its root, trunk and branches, called *Arbor Dianæ*, or the philoſophic Silver-tree. Lemery gives another method of making an Arbor Dianæ, by adding to ſolution of Silver ſome warm diſtilled Vinegar (*z*)——Silver is precipitated from its ſolution by (*a*) Copper, Iron, Tin and Zinc. Copper is commonly made choice Arbor Dianæ. Precipitation of Silver.

(*y*) *Cryſtals.*] The Cryſtals of Silver ſhoot into thin, colourleſs, tranſparent plates, approaching to a triangular figure. They readily diſſolve in water; and by the aſſiſtance of warmth, in Spirit of Wine. Expoſed for ſome time to a moderately ſtrong fire, they part by degrees with all the acid, and return into Silver again; though ſcarcely without ſome little loſs, unleſs borax or alcaline fluxes are added, to collect and reunite the particles of the metal—If laid on a burning coal, the nitrous acid, deflagrating with the inflammable matter, as this acid in all its combinations does, is quickly conſumed, and the Silver revived. I have not obſerved in this experiment any conſiderable volatilization of the Silver; though in the *Acta naturæ curioſorum*, *tom.* vi. there is a remarkable hiſtory of Silver diſſolved in the nitrous acid being volatilized in cloſe veſſels by means of Charcoal. Four ounces of pure Silver being diſſolved in Aqua fortis, and the ſolution ſet to diſtil in an earthen retort; a white tranſparent butter aroſe into the neck, and nothing remained behind: By degrees the butter liquefied, and paſſed down into the phlegm in the receiver: The whole being now poured back into the retort, the Silver aroſe again along with the acid: On adding Sea-Salt to this volatilized ſolution, the Silver was precipitated into a Luna Cornea. The volatilization being attributed to the liquor having ſtood in an elaboratory where Charcoal was bringing in, the experiment was repeated with a freſh ſolution of Silver mixed with a little powdered Charcoal; with the ſame event.

(*z*) *Vegetations.*] Another kind of artificial vegetation, as it is called, may be produced, by ſpreading a few drops of ſolution of Silver upon a glaſs-plate; and placing in the middle a ſmall bit of any of the metals that precipitate Silver, as particularly of Iron. The Silver quickly concretes into curious ramifications all over the ſurface of the plate. Other metallic ſolutions afford alſo vegetations on the ſame treatment; but none ſo elegant ones as that of Silver.

(*a*) *Precipitation of Silver.*] Silver is precipitated from Aqua fortis by all the metals which

SILVER. choice of, the Precipitate obtained by that metal being the pureſt, though it is never entirely free from ſome portion of the Copper. This calx is employed for cold ſilvering; mixed with Nitre, Sal Ammoniac and common Salt, in the proportion of one part of each of the Salts to two of the lunar Calx: Some, inſtead of the Precipitate, take Silver leaf, with equal its weight of Creme of Tartar, and the ſame quantity of common Salt.

Combination of Silver with the marine acid.

The marine acid does not diſſolve Silver (*b*), but precipitates it from the nitrous. Upon adding, to a ſolution of the metal made in Aqua fortis, either the pure acid of Sea-Salt, or the Salt in ſubſtance, or Sal Ammoniac, the liquor inſtantly becomes milky, and on ſtanding depoſites the Silver now combined which diſſolve in that acid; readily and copiouſly at firſt; but ſlowly and difficultly towards the end. The menſtruum generally retains ſome portion of the Silver, as the Silver almoſt always does of the metal which precipitated it——The refiners, for recovering the Silver from Aqua fortis after parting, employ Copper. The ſolution, diluted with water, is put into a copper-veſſel, or into a glaſs one with thin plates of Copper, and ſet in a gentle warmth: The Silver begins immediately to ſeparate from the liquor in form of fine grey ſcales or powder; a part of the Copper being diſſolved in its place, ſo as to tinge the fluid more and more of a bluiſh-green colour: The plates are now and then ſhaken, that ſuch part of the Silver, as is depoſited upon them, may fall off and ſettle to the bottom. The digeſtion is continued, till a freſh, bright plate, kept for ſome time in the warm liquor, is no longer obſerved to contract any powdery matter on the ſurface; when the liquor is poured off, and the Precipitate waſhed with freſh parcels of boiling water. The ſmall portion of Silver, which the acid commonly ſtill retains, may be precipitated by common Salt: The Copper, which the Silver retains, may be in part ſcorified and ſeparated by fuſion with Nitre. It is obſervable, that though the Acid in this proceſs, ſaturates itſelf with the Copper in proportion as it lets go the Silver; yet the quantity of Copper, which it takes up, is not near ſo great as that of the Silver which it depoſites. One dram of Copper will precipitate three of Silver, and ſaturate all the acid that held the three drams diſſolved.

Abſorbent earths, as Chalk or Quick-lime, throw down a part of the Silver, but leave a very conſiderable part ſuſpended in the liquor. If the earth be moiſtened with the ſolution into the conſiſtence of a paſte, and expoſed to the ſun, it changes its white colour to a dark purpliſh black: Diſtinct characters may be exhibited on the matter, by intercepting a part of the ſun's light by threads, ſlit paper, *&c.* placed on the outſide of the glaſs. Culinary fire does not affect its colour: After the maſs has been exſiccated by this, it changes as before upon expoſure to the ſun.

Volatile alcaline Spirits, added to a ſolution of Silver, precipitate little. Pure fixed Alcalies, and Alcalies, rendered cauſtic by Quick-lime, throw down the whole. Fixt Alcalies impregnated with inflammable matter by calcination with animal coals, occaſion at firſt a conſiderable precipitation, but if added in larger quantity, take up great part of the metal again. Mr. Marggraf relates, that edulcorated calces of Silver totally diſſolve both in a lixivium of theſe Alcalies and in volatile Spirits; and that the marine acid precipitates the Silver from the volatile, but not from the fixed alcaline ſolution——Kunckel reports, that the calx precipitated by volatile ſpirits made with Quick-lime, fulminates or explodes in the fire: And that by inſpiſſating a ſolution of pure Silver, melting the dry reſiduum, pouring on it Spirit of Urine ſuperſaturated with Salt, and ſetting the mixture in a gentle warmth, a blood-red maſs is produced, ſo tough as to be wound about the fingers.

(*b*) *Marine acid.*] Strong Spirit of Salt corrodes leaf Silver into a white powder: On filings or larger maſſes, it has no effect. The highly concentrated acid, applied, in the form of vapour, to maſſes of Silver at the ſame time ſtrongly heated, readily corrodes

combined with the marine acid into a white powder. This, when ſufficiently waſhed with water, proves inſipid, though containing ſo much acid as to weigh one fourth more than the Silver employed. It does not diſſolve in water, Spirit of Wine, Aqua fortis or Aqua regis; but is in ſome ſmall degree acted on by the vitriolic acid. It melts in the fire as ſoon as it begins to grow red-hot, and on cooling forms a ponderous browniſh maſs, which if caſt into thin plates, proves ſemi-tranſparent and ſomewhat flexible, like horn; whence its name *Luna Cornea*. A ſtronger fire does not expel the acid from the Silver; the whole concrete either ariſing in fumes, or ſinking through the veſſel, without any ſeparation of its parts: It may be ſublimed like Arſenic, with which it has in many reſpects a great analogy. If mixed with fixt alcaline Salts, or inflammable ſubſtances as Oil or Tallow, and melted in a crucible, the acid is abſorbed or expelled, and the Silver recovered pure (*c*).

Luna Cornea.

Silver volatilized.

The

rodes them. Thus if filings, grains or plates of the metal be mixed with about twice their weight of Mercury ſublimate, and expoſed to a moderate fire in a retort or other proper veſſel; the marine acid of the ſublimate will be abſorbed by the Silver, and form with it a Luna Cornea; whilſt the Mercury, now diſengaged from the acid, diſtils in its running form——The marine acid is commonly ſuppoſed incapable of diſſolving Silver into a liquid ſtate. Henckel reports, in his tract *de appropriatione*, that if the red Silver Ore (which conſiſts of Silver intimately blended with red Arſenic) be digeſted in Spirit of Salt, the Silver will be extracted and kept permanently diſſolved.

(*c*) *Luna Cornea—Silver recovered pure.*] Luna Cornea is moſt commodiouſly prepared, by diluting a ſolution of Silver with ten or twelve times its quantity of water, and adding by degrees a ſolution of Sea-Salt, ſo long as it occaſions any turbidneſs or milky hue. The whole is then to be ſet by till the white powder has ſettled; when the clear liquor is to be poured off, and the precipitate waſhed with freſh parcels of boiling water. If the Silver contained any portion of Copper, which it always does after the common methods of purification, that metal will here be ſeparated, and left diſſolved in the liquor; pure Sea-Salt precipitating no metallic body but Silver, Lead, and Mercury. Hence Silver is brought by this proceſs to a degree of purity ſcarce procurable by any other known means.

The Silver may be recovered from the Luna Cornea, by fuſion with alcaline and inflammable fluxes as directed by the author, or with certain metallic bodies: But in theſe operations, there happens always a conſiderable loſs of the Silver; a part of the volatile calx being diſſipated by the fire, before the alcali or metal can abſorb its acid. Mr. Marggraf has diſcovered a method of reviving the Silver with little or no loſs; Mercury, aſſiſted by volatile Salts, imbibing it by trituration without heat. One part of Luna Cornea and two of volatile Salt are to be ground together in a glaſs mortar, with ſo much water as will reduce them into the conſiſtence of a thin paſte, for a quarter of an hour or more: Five parts of pure Quick-ſilver are then to be added, with a little more water, and the triture continued for ſome hours. A fine amalgam will thus be obtained; which is to be waſhed with freſh parcels of water, ſo long as any white powder ſeparates. Nearly the whole of the Silver is contained in the amalgam, and may be recovered perfectly pure by diſtilling off the Mercury. The white powder holds alſo a ſmall proportion, ſeparable by gentle ſublimation: The matter which ſublimes is nearly ſimilar to Mercurius dulcis.

Luna Cornea totally diſſolves in volatile alcaline Spirits, without any ſeparation of the metal——Expoſed to the fire in a cloſe copper veſſel, it penetrates the Copper, and tinges it throughout of a Silver colour——Kunckel obſerves, that when carefully prepared, melted in a glaſs veſſel, and ſuffered to cool ſlowly (to prevent its cracking,) it

proves

SILVER.

Combination with the vitriolic acid.

The vitriolic acid alſo precipitates Silver from the nitrous; but does not act upon Silver in its metallic ſtate, unleſs highly concentrated and aſſiſted by a boiling heat (*d*). The marine acid precipitates Silver from the vitriolic, in the ſame manner as from the nitrous.

Amalgamation.

Mercury very readily amalgamates with Silver leaf. It eaſily unites likewiſe with the calx of Silver precipitated by Copper; but does not touch the calces precipitated by Salts.

Silver with Sulphur.

The vapours of ſulphureous ſolutions ſtain Silver yellow or black. Sulphur melted with Silver debaſes its colour to a leaden hue, renders it more eaſily fuſible than, and makes it flow ſo thin, as to be apt in a little time to penetrate the crucible: In a heat juſt below fuſion, a part of the Silver ſhoots up, all over the ſurface, into capillary efflorescences. Aqua fortis, the ſolvent of pure Silver, does not act upon the Silver in this compound; but fixt alcaline Salts, the menſtruum of Sulphur, may be made to abſorb that ingredient; the Alcali however, when combined with the Sulphur, will take up the Silver again. If the ſulphurated Silver be mixed with Mercury ſublimate, and expoſed to the fire, the Mercury of the ſublimate will unite with the Sulphur, and carry it up in the form of Cinnabar; whilſt the marine Acid of the ſublimate unites with the Silver into a Luna Cornea which remains at the bottom of the glaſs. Fire alone, continued for ſome time, is ſufficient to expel the Sulphur from Silver.

Purification of Silver.

Tinctura Lunæ.

Silver is purified from the baſer metals by cupellation with Lead. It always retains however after that operation ſome ſmall portion of Copper, ſufficient to impregnate volatile Spirits with a blue tincture, which ſome have erroneouſly ſuppoſed to proceed from the Silver itſelf. It is purified from this admixture by melting it twice or thrice with Nitre and Borax: The Scoriæ, on the firſt fuſion, are commonly blue; on the ſecond, green; and on the third, white, a mark of the purification being completed. But the moſt effectual purification is the revival of Silver from Luna Cornea.

Silver boiled white.

Silver is purified and whitened externally by boiling in a ſolution of Tartar and common Salt. This is no other than an extraction of the cupreous particles from the ſurface of the Silver, by the acid of the Tartar acuated with the common Salt.

The

proves clear and tranſparent, may be turned in a lathe, and formed into elegant figures. He ſuppoſes this to be the preparation which gave riſe to the notion of malleable Glaſs.

(*d*) *Silver with the vitriolic acid.*] Oil of Vitriol, aſſiſted by a boiling heat, corrodes into a ſaline maſs half its weight of Silver filings. This compound diſcovers a remarkable attraction to Mercury: It coagulates and hardens as much Quick-ſilver as the acid weighed at firſt: If the hard concrete be diluted with freſh acid, it melts eaſily in the fire, and does not part with the Mercury in the greateſt heat that glaſs veſſels can ſupport. The vitriolic acid by itſelf ſtrongly retains Mercury; but not near ſo much ſo, as when thus combined with Silver.

Silver thus corroded by the vitriolic acid, or precipitated by it from the nitrous, may be in great part diſſolved into a liquid ſtate, by cautiouſly applying a very little water at a time; and more effectually, by repeating the coction in freſh Oil of Vitriol. The calx precipitated from this ſolution by the marine acid is ſaid by Kunckel to be more volatile and penetrating than the common Luna Cornea.

The Silver employed for coins and utenſils, has always an admixture of Copper, which improves its hardneſs and ſonorouſneſs. Its degree of fineneſs is expreſſed among us by *loths* or half ounces: A *marck* contains ſixteen half ounces: The Silver is ſaid to be of ſixteen *loths*, when all the ſixteen half ounces are pure Silver; of fifteen, when only fifteen half ounces are pure Silver and the other Copper, *&c.*——Moſt of the other metallic bodies render it brittle: One part of Tin deſtroys the malleability of above an hundred parts of Silver; and Regulus of Antimony has this effect in a ſtill greater degree. Both Regulus of Antimony and Arſenic render a part of the Silver volatile in the fire (*e*). SILVER. Alloy.

Silver is found in all countries; but moſt plentifully in America, particularly in Peru and Potoſi, from whence large quantities are brought annually into Europe. It is met with either in its perfect metallic ſtate, or in the form of Ore, or blended in the Ores of other metals. Where found.

Native malleable Silver occurs not unfrequently, in different Stones, Earths, and in moſt kinds of Sands; in ſmall pieces, of different figures, chiefly filaments or ſcales. It generally contains ſomewhat arſenical, but never holds any Gold, though native Gold is ſeldom free from Silver. Native Silver.

The

(*e*) *Silver with other metals.*] Its colour is debaſed by all the metals, and its malleability greatly injured by all but Gold and Copper: The Engliſh ſtandard Silver contains one part of Copper to twelve and one third of pure Silver——Silver diſcovers, in ſome circumſtances, a great attraction to Lead; though it does not retain any of that metal in cupellation, as Gold does. If a mixture of Silver and Copper be melted with Lead, in certain proportions, and the compound afterwards expoſed to a moderate fire, the Lead and Silver will melt out together, bringing very little of the Copper with them: By this method, Silver is often ſeparated from Copper in the large works. The effect does not depend wholly upon the different fuſibility of the metals; for if Tin, which is ſtill more fuſible than Lead, be treated in the ſame manner with a mixture of Copper and Silver, there will be no eliquation; the three ingredients, here, ſtrongly attracting one another, ſo as to come all into fuſion together. Again, if Silver be melted with Iron, and Lead added to the mixture; the Silver will forſake the Iron to unite with the Lead, and the Iron will float by itſelf on the ſurface.

Silver with vitreous matters.] Precipitates or calces of Silver melted with vitreous ſubſtances, impart to them a yellow colour. Kunckel obſerves, that when the glaſs is ſtrongly ſtirred in fuſion with an Iron rod, or blown into veſſels, it changes its uniform tinge into an opake milkineſs, variegated with yellow and other colours: The preparation of Silver he employs is Luna Cornea. This, or the other precipitates, ſpread upon a glaſs plate, adhere and ſtain it yellow by ignition without fuſion: Hence their uſe in painting on Glaſs.

The moſt beautiful yellow enamel for Porcelane hitherto diſcovered (communicated in the Phil. Tranſ. and the Swediſh Acts) owes its colour to Silver. A Glaſs made from three parts of Litharge and one of Flint, is reduced into groſs powder, and a ſolution of about one twentieth its weight of Silver poured upon it: The mixture is ſtirred together, exſiccated and melted again, and when in thin fuſion poured out. This compoſition, ground into fine powder, is applied on the Porcelane previouſly heated; and the ignition continued, under a muffle, till the powder melts, which is known by its gliſtening. The ware is then taken out of the furnace, and, whilſt it continues red-hot, held over the ſmoke of burning vegetables, which calls forth the beautiful colour.

SILVER. Ores of Silver.

The principal ores of Silver are, (1.) *Ganſekotbig ertz*, gooſe-dung ore, ſo called from its colour; this is ſurrounded, and penetrated with efflorescences of capillary Silver. (2.) *Glaſertz*; compoſed of Silver and Sulphur. This ore is of an irregular figure, ſometimes cubical, ſometimes of eight or more ſides. When pure, it may be hammered or cut almoſt like Lead; but if penetrated by foreign matters it falls in pieces from a blow: The pieces ſingly prove malleable. There are ſome ſorts brittle throughout, probably from an admixture of Arſenic. Its colour is blackiſh, ſometimes brighter, and ſometimes darker: There is one ſort of a grey colour almoſt like the fallow ore, but differing from that ore in containing no Copper. It melts in the fire as ſoon as it begins to grow red-hot. Its yield of Silver is variable, but always large, amounting commonly to about three fourths of its weight. (3.) *Hornertz*, horn ore; externally irregular, internally compoſed of fine leaves laid together and ſemi-tranſparent like horn. It yields, like the foregoing, both to the hammer and the knife. Its colour is whitiſh, yelloviſh or browniſh: It is commonly foul on the outſide, but may be eaſily diſtinguiſhed by cutting or bending it. In the fire it emits both an arſenical and ſulphureous fume; and commonly affords two thirds its weight of Silver. (4.) *Rothgulden ertz*, red Silver ore, is ſometimes of a deep tranſparent red, and ſometimes darker. It is diſtinguiſhed from Cinnabar, by its colour inclining not to an aurora or brick red, but to the garnet or ruby red, or a purple red; though there are red Silver ores alſo of a dull brick hue: The colour of Cinnabar is improved, but that of the Silver ores debaſed, by grinding them into fine powder. This ore is very ponderous, melts in the fire before it becomes red-hot, and emits thick fumes ſmelling ſtrongly of Arſenic. It conſiſts of Silver and Arſenic, with a little Sulphur; and with theſe ingredients, or with equal parts of Arſenic and native Silver, it may be imitated by art. The quantity of Silver in the deep red ſorts is commonly from ſixty to ſixty-two pounds on the hundred: The yield of the darker kinds is inconſtant: Theſe laſt hold commonly a little Iron. (5.) *Weiſſgulden ertz*, white Silver ore, is of a bright grey colour, ponderous, and brittle. When pure, it contains ſeven pounds of Silver on the hundred, but a larger quantity of Copper. It conſiſts of Silver, Copper, Antimony, Arſenic, and Sulphur. Several ſorts contain likewiſe Iron, and hold but very little Silver, as two ounces on the hundred weight: Theſe are of a paler and brighter colour than the others, and called plain *Weiſſertz*, white ore. The white Silver ores have a great reſemblance in colour to the paler cobalts; theſe laſt however are ſenſibly whiter, and incline a little, like Biſmuth, to a reddiſh or yelloviſh caſt. (6.) The *fahlertz* and *fahlkupferertz*, fallow ore and fallow Copper ore, are ranked among the ores of Silver, though they belong more properly to thoſe of Copper. Their colour is a dark grey. They are found among, and ſometimes blended with Copper ores and Copper pyritæ. They hold from four ounces to ſome pounds of Silver upon the hundred. (7.) *Federertz*, feather ore, is compoſed of extremely fine fibres or hairs: It holds two ounces of Silver on the hundred weight, and contains both Arſenic and Sulphur, for it yields on ſublimation a yellow Arſenic. (8.) *Ruſs*, ſooty ore, conſiſts of a fine, ſoft, black duſt, which is commonly lodged in clefts: It is very rich in Silver, yielding ſometimes half its weight.

Silver is extracted from its matrices by amalgamation with Mercury; and from its true ores by fusion, or by scorification with Lead in the same manner as Gold (*f*). SILVER.

CLASS II. IMPERFECT METALS.

Malleable metals;—resisting the fire in close vessels;—in open ones, calcining;—when calcined, or corroded by Acids, not revivable again into their metallic form without the addition of inflammable matter.

IMP. MET. BODIES.

THESE metals appear actually to contain an inflammable principle, which is burnt out in the calcination, and extracted from them by acids. Nitre, which deflagrates with and dissipates the inflammable principle wherever it is to be found, deflagrates with the imperfect metals, and thus occasions instantly the same change that fire alone would more slowly produce: Some of these metals emit visible flames by themselves.

Contain an inflammable matter.

The phlogistic principle is the same in one metal as in another, in metals as in other bodies, in the mineral as in the vegetable and animal kingdoms. When metals, by the loss of their own phlogiston, have been changed into a calx or vitreous mass; the introduction of any other inflammable matter, from vegetables or animals, Charcoal, Resins, Oils, Fats, *&c.* instantly restores their metallic appearance, and all their pristine qualities.

Their inflammable part the same with that of vegetables and animals.

The calx differs greatly in different metals: It is on this, that the distinguishing characters of each particular metal depend, the calx of one metal forming always with phlogiston no other than the same metal again. These calces are supposed to consist of a certain fixed vitrescible earth, and a more volatile

Their other principles.

(*f*) *Extraction of Silver from the ore.*] In the mines of the Spanish West-Indies, the Silver is for the most part native, or only embedded in earths and stones, so as to be separable by comminution, ablution, and amalgamation, nearly in the same manner as Gold. The method of conducting the process is particularly described by Alonso Barba.

The proper ores of Silver are most common in Germany: The black malleable ore, the second of those above enumerated, is the only one that has been met with in England, and this but rarely. The Silver is extracted by calcination and fusion. The Sulphur and Arsenic, (one, or other, or both of which, are blended in all the true ores of Silver) are totally dissipable by simple calcination; Silver having little affinity with those minerals, and parting with them more readily than any of the baser metals does: The Silver may afterwards be separated from the remaining earthy or stony matters, by fusion or scorification with Lead, which answers the same purposes here as in the extraction of Gold from its ores or matrices, see page 40. Silver may likewise be got out from the ore, by fusion with a large portion of Lead without calcination, and in some cases to better advantage than when that process is premised: For Lead absorbs from this metal both Arsenic and Sulphur; and Arsenic remarkably promotes the vitrification of Lead, and forms with it a glass far more active as a flux for refractory matters than the simple glass of Lead.

Most of the English Lead ores contain some portion of Silver; and some of them so much as to be worked for this metal to advantage: Those of Cardiganshire are said to yield from ten to twenty pounds on the tun. These are first run down as other Lead ores; and the Silver afterwards extracted from the Lead, by working off the Lead upon a test.

IMP. MET. BODIES.

latile principle called mercurial. When metals have been but barely calcined, they have loſt only their phlogiſton, and are recoverable by the introduction of freſh phlogiſton: A more thorough calcination, by long continuance of fire or by additions, diſſipates a part of this mercurial principle; and as no method has been diſcovered of ſupplying it by art, the quantity of metal revivable will be proportionably leſs. The proceſs is capable of being carried ſo far, that no metal at all ſhall be recovered, and that the calx ſhall differ but little from a mere earth.

The perfect metals, of the foregoing claſs, though not reſoluble by theſe operations into any diſſimilar parts, are ſuppoſed, from analogy, to conſiſt of the like principles.

I. LEAD.

LEAD.

LEAD, *Saturn*, is a pale or livid white metal; ſoon loſing its brightneſs in the air, and contracting a blackiſh or greyiſh aſh colour; very ſoft and flexible (*g*); unelaſtic and unſonorous; the heavieſt of all metallic bodies but Gold, Quickſilver [and Platina]: It is upwards of eleven times heavier than an equal bulk of water.

Gravity,

Fuſibility,

It melts in a very ſmall degree of fire, long before it grows red-hot: In a ſtrong red heat, it boils, and emits viſible fumes (*h*).

Granulation.

It loſes of its malleability in proportion as it is heated: By nimble agitation, when it is juſt ready

(*g*) *Lead—flexible*, &c.] Lead is the ſofteſt and moſt flexible of all metallic bodies; eaſily cut with a knife, ſhaved with a plane, grooved for windows by being drawn through the glazier's vice, flatted, by paſſing betwixt wooden rollers, into large thin ſheets. When broke by repeated bendings, backwards and forwards, each piece appears drawn out ſmooth to an edge, like the fracture of well nealed Gold or Silver. It is not however ductile to any great degree, either in the form of wire or of leaf; in this reſpect coming far ſhort of all the other malleable metals.

Some have preferred, for mechanic uſes, the milled Lead, or flatted ſheets, to the caſt; as being more equal, ſmooth, and ſolid. But whatever advantages of this kind, the milled ſort may appear to have at firſt, they are not found to be very durable. When the Lead is ſtretched between the rollers, its cavities muſt neceſſarily be enlarged: The particles of metal, that may be ſqueezed into them, can have no union or adheſion with the contiguous particles; and of conſequence muſt be liable, from bending, blows, jarrs, or other ſlight external cauſes, to ſtart out again, and leave the maſs ſpongy and porous.

Lead yields the dulleſt and weakeſt ſound of all metallic bodies. Reaumur obſerves, that it is rendered ſonorous, by caſting a ſmall quantity into a ſpherical or elliptical ſegment, as in the bottom of an Iron ladle: from hence he conjectures, that the ſound of the ſonorous metals might be improved, for the bells of clocks, &c. by giving them a ſimilar form.

(*h*) *Fuſibility of Lead.*] It melts a little later than Tin or Biſmuth; much ſooner than any other metal; about the five hundred and fortieth degree of Fahrenheit's thermometer. The plumbers caſt thin ſheets of Lead upon a table or mould, covered with a woollen and above this a linen cloth, without burning or ſcorching the cloths: The melted Lead is received in a wooden caſe without a bottom, which being drawn down the ſloping table by a man at each ſide, leaves a ſheet, of its own width, and more or leſs thin according to the greater or leſs celerity of its deſcent——For thick plates, the table is covered with moiſtened ſand, and the liquid metal conducted evenly over it, by a wooden ſtrike which bears on a ledge at each ſide.

ready to melt, or when returning from a fluid to a conſiſtent ſtate, it may be divided into ſmall grains or powder. Granulated Lead is commonly prepared, by pouring the melted metal into a wooden box rubbed on the inſide with Chalk, and ſtrongly ſhaking it till it ſets or becomes ſolid: When large quantities are prepared, a wooden trough is made uſe of. It is formed into round granules or ſhot, by pouring the melted Lead into cold water, through a perforated plate; a little Orpiment being added to the metal in fuſion; this improves its hardneſs, and makes it run more regularly into globules without drawing a tail. LEAD. Shot.

Lead when juſt become fluid, looks bright like Quickſilver; but preſently contracts on the ſurface a variouſly coloured powdery pellicle. Some have ſuppoſed that this was an heterogeneous ſubſtance; and that the Lead, by its ſeparation, became purer. But after this imaginary purification, it will ſtill, upon continuing the fire, exhibit a pellicle as at firſt: If this is taken off, or the metal ſtirred, ſo as to expoſe a freſh ſurface to the air, a new one will ariſe, till by degrees the whole quantity is changed into a duſky powder or calx, called *plumbum uſtum*. The injection of a little fat, charcoal powder, or other inflammable matters, prevents this change, and readily revives the calx into Lead again, notwithſtanding Boerhaave's aſſertion that the calx of Lead is very hard to reduce (*i*). Calcination. Revival of the calx.

Calx of Lead expoſed to the fire in a furnace ſo contrived as that the flame may play upon its ſurface, becomes white, yellow, and at length of a bright red colour; hence the yellow Lead or Maſticot, and the red Lead or Minium of the painters. Some ſuppoſe the converſion of Lead into Minium to be an effect of ſimple calcination, produced by the heat acting through the ſides of the veſſel; but no degree of heat will change the calx to a red colour, without the immediate contact of ſmoky flame. The metal acquires, in this operation, an increaſe of its weight, nineteen pounds of Lead yielding twenty pounds Maſticot and Minium.

(*i*) *Calx of Lead revived.*] The calces and the glaſs of Lead are extremely eaſy of revival; more ſo than thoſe of any other metal.

Common Flint glaſs contains a large proportion of vitrified Lead: I have extracted from it one fourth its weight of perfect malleable Lead. If a piece of this glaſs be ſurrounded in a crucible with Soot, powdered Charcoal, or other like inflammable matters, and cemented for ſome time with a fire inſufficient to melt it, the Lead will be revived throughout the whole internal ſubſtance of the glaſs, into little drops: If the matter is brought into fuſion, the Lead ſubſides, collected into one button at the bottom. This experiment affords a remarkable inſtance, not only of the eaſy reducibility of Lead, but of the penetrability of Glaſs, a ſubſtance which is looked upon as impervious to all kinds of fumes. I have ſeen innumerable globules of Lead thus revived in the middle of glaſs-ſtoppers above an inch thick, without the leaſt viſible crack or eroſion of the ſurface.

Wafers are coloured red by the red calx of Lead called Minium. On holding a Wafer barely in the flame of a candle, its Lead is preſently reduced, and runs down in drops.

The calces and glaſs of this metal abſorb the inflammable principle even from ſome other metallic bodies. If glaſs of Lead be melted in an Iron veſſel, or ſtirred in fuſion with an Iron rod, great part of the Lead will reſume its metallic form, a proportionable quantity of the Iron ſcorifying.

It is ſaid, that Lead, recovered from its calces, proves ſomewhat harder and whiter than at firſt, and leſs ſubject to tarniſh in the air. The difference, if any, is certainly very ſmall.

LEAD. pounds of Minium——The largeſt quantities of Minium are made at Venice, and in England. The Venetians employ for the beſt ſort, called *minio fine*, Ceruſſe or white Lead; for the middling ſort, *minio meſan*, the refuſe plates of Lead remaining after the making of Ceruſſe: The worſt kind, *minio ordinare*, is prepared from Litharge (*k*).

Litharge. If Lead be urged with a bright red heat, it changes by degrees into a yellow, flaky ſcoria, called Litharge, of a paler or deeper colour according to the degree of fire it has undergone: The paler ſort is diſtinguiſhed by the name of Litharge of Silver, the darker by that of Litharge of Gold; though neither of them contains any portion of thoſe metals (*l*).

Glaſs of Lead. All the calces and ſcoriæ of Lead vitrify more eaſily than thoſe of any other metal: Expoſed to a moderately ſtrong fire, they quickly run into a tranſparent yellow glaſs. This glaſs, in fuſion, powerfully diſſolves and vitrifies the more refractory metallic calces and earths; and unleſs ſaturated with theſe kinds of additions, corrodes and ſinks through the common crucibles (*m*).

Purification of Gold and Silver by Lead. If Gold or Silver be mixed with Lead, and expoſed to the fire, the Lead ſcorifies, as it would by itſelf, and ariſes to the ſurface, ſo as to be raked off in the form of Glaſs or Litharge; at the ſame time carrying with it any imperfect metal that the Gold or Silver had been mixed with, but leaving thoſe perfect metals themſelves unhurt. Hence Gold and Silver are purified by means of Lead from admixtures of the baſer metals; and hence Lead is called by the chemiſts, *balneum ſolis & lunæ*, *lavacrum regis & reginæ*, *ſapo metallorum*, &c.—The Litharge met with in the ſhops is produced in thoſe works where Gold and Silver are thus purified; and contains the heterogeneous metals which the Gold or Silver had been mixed with.

If

(*k*) *Minium.*] Minium is commonly prepared from Lead calcined into a greyiſh powder by keeping it melted over the fire. This powder, ground in mills, is further calcined, in a reverberatory furnace, under a low arch, and frequently ſtirred with an Iron rake, to prevent its melting and running into clots, and to expoſe a freſh ſurface to the action of the air and flame. The calcination laſts two or three days. The increaſe of weight is ſaid to amount to one fourth the weight of the Lead; and the Lead recovered from the Minium to be one twentieth leſs than the original weight of the metal. If the Minium be further calcined, the increaſe is no more; but the quantity of Lead recoverable proves leſs in proportion to the vehemence and continuance of the calcination.

(*l*) *Litharge.*] The deep coloured Litharge is the moſt perfect ſort: The pale contains a conſiderable portion of Lead in its metallic ſtate, or uncalcined, and hence is never to be employed for ſuch operations as demand a true calx or ſcoria of Lead. Even the higheſt coloured Litharge is ſeldom free from a little metallic Lead; diſcoverable, and ſeparable, by melting the maſs in a crucible, when the Lead ſubſides to the bottom.

(*m*) *Glaſs of Lead—diſſolves earths*, &c. *in fuſion.*] Hence the uſe of Lead in vitrifications; whether for procuring a fine tranſparent glaſs, or for bringing refractory minerals, that participate of Gold or Silver, into thin fuſion, in order to the ſeparation of thoſe metals. The glaſſes made with it are ſoft: And hence its unfitneſs as a baſis for paſtes and artificial gems, though it anſwers extremely well in point of tranſparency, luſtre, and beauty of the colours. It is obſervable, that calces of Lead diſſolve or vitrify ſand very eaſily, but clay very difficultly; hence crucibles, in whoſe compoſition ſand is an ingredient, are the ſooneſt corroded by them: Calces of Iron, on the contrary, render clay fuſible, and ſand refractory.

If Glaſs of Lead be reduced into Lead, and the revived Lead ſcorified again, there commonly remains a ſmall grain of Silver: If the Glaſs produced in this operation be again revived, another granule of Silver will be left upon a ſecond ſcorification. There is a certain experiment, in which, by gradually taking away from the mercurial earth and adding to the inflammable and vitreſcible, greateſt part of Lead, is [ſaid to be] convertible into Silver.

Silver produced from Lead.

Lead mixed with Tin calcines ſooner than by itſelf: One pound of Tin quickly incinerates ten pounds of Lead (*n*). With Arſenic it runs into a hyacinth coloured extremely fuſible Glaſs: But Sulphur, which promotes the fuſion of many of the metals, renders Lead remarkably difficult of fuſion. Lead expoſed to the focus of Tſchirnhaus's burning lens, firſt ſmokes, then looks

Calcination with Tin.

Hyacinth Glaſs with Arſenic.

Expoſed to a burning-glaſs.

(*n*) *Lead with other metals.*] Lead mingles in fuſion with all the metals except Iron; with which it refuſes any degree of union, ſo long as the Lead preſerves its metallic form. On continuing the fire, the Lead, ſcorifying or calcining, abſorbs the phlogiſtic principle of the Iron, and conſequently promotes the calcination of that metal: both being at length reduced into calces, the fuſible ſaturnine calx diſſolves the chalybeate into an opake brown or blackiſh Glaſs.

Copper does not unite with melted Lead till the fire is raiſed ſo high, as to make the Lead boil and ſmoke, and of a bright red heat: Pieces of Copper, now thrown in, ſoon diſſolve and diſappear in the Lead: The mixture when cold, is brittle, and its fracture of a granulated texture. The union of theſe two metals is remarkably ſlight: On expoſing the mixture to a fire no greater than that in which Lead melts, the Lead almoſt entirely runs off by itſelf; a ſeparation, of which we do not know one other example. What little Lead is retained in the pores of the Copper, may be ſcorified and melted out by a fire conſiderably leſs than is ſufficient to make Copper flow. If any of the Copper is carried off by the Lead, it ſwims unmelted upon the ſurface, ſo as to be eaſily ſcummed off. The coarſer ſorts of Lead, which owe their brittleneſs and their granulated texture to an admixture of Copper, throw up their Copper in the ſame manner on being melted by a ſmall heat, and thus become ſoft and malleable.

Tin unites very eaſily with Lead, into a compound more fuſible than Lead by itſelf, and which is hence employed as a ſolder for Lead. In point of malleability, Lead, of all the metals, ſuffers the leaſt from Tin; becoming only a little more hard. The metal, commonly made uſe of for organ-pipes, is ſaid to be compoſed of twelve parts of Lead and one of Tin.

Gold and Silver are diſſolved by melted Lead in a ſlight red heat. They are both rendered extremely brittle by the minuteſt quantity of Lead; though Lead is rendered more ductile by a ſmall quantity of either of them.

The affinities of Lead to different metals are very remarkable. In cupellation, a portion of it is retained by Gold; but Silver parts with it all. On the other hand, in its eliquation from Copper, if the Copper contains either of the precious metals, the Silver, will totally melt out with the Lead, but Gold will not. The attraction of Lead to Copper, however ſlight, is greater than that of Copper to Iron: A mixture of Copper and Iron being boiled in melted Lead, the Copper is imbibed by the Lead, and the Iron thrown up to the top. Silver is in like manner imbibed from Iron by Lead, whilſt Tin on the contrary is imbibed from Lead by Iron. If two mixtures, one of Lead and Tin, and another of Iron and Silver, be melted together, the reſult will be two new combinations, one of the Tin with the Iron on the top, the other of the Lead with the Silver at the bottom: How carefully ſoever the matter be ſtirred and mixed in fuſion, the two compounds, when grown cold, are found diſtinct, ſo as to be readily parted by a blow. The affinities or attractions of metals to one another are no where more conſpicuous, nor the ſeparations depending upon them more perfect, than in theſe examples.

LEAD. looks like melted Reſin, and at length changes into a ſoft, yellowiſh, greeniſh, and reddiſh Glaſs.

Solution in the nitrous acid.

Lead diſſolves in the nitrous Acid into a yellow liquor: The ſolution, inſpiſſated, explodes or fulminates in the fire (*o*). The marine acid, added to the ſolution, precipitates the Lead in the ſame manner as it does Silver: And the Precipitate, like the combination of the ſame Acid with that metal, has, when melted, ſome degree of flexibility and tranſparency, ſomewhat reſembling horn; whence its name *Saturnus Corneus*. If Lead or Minium be mixed with Sal Ammoniac and expoſed to the fire, the volatile alcali of the Salt is extricated, and its acid abſorbed by the Lead: The ſpirit which diſtills on this occaſion, like that prepared by Quicklime, is extremely volatile and cauſtic, and yields no concrete Salt: Its quantity is but ſmall.

Saturnus Corneus.

Cauſtic ſpirit from Sal Ammoniac.

Ceruſſe.

Lead expoſed for ſome time to the ſteam of Vinegar or other vegetable acids, is gradually corroded into a white calx, which is the Ceruſſe or white Lead of the ſhops. The beſt ſort of Ceruſſe is in large thick flakes: The powder ſorts are commonly adulterated with an admixture of Chalk or whiting. The greateſt quantities are made at Venice, Amſterdam, and in England.

Vegetable

(*o*) *Menſtrua of Lead.*] Proof Aqua fortis, lowered with an equal quantity of water, diſſolves about half its weight of Lead. On diluting the ſolution with a large quantity of water, it turns milky, and depoſites the metal. The ſolution ſhoots, upon exhaling a part of the menſtruum, into ſmall pyramidal cryſtals with ſquare baſes, of an auſtere ſweet taſte.

In the Memoirs of the French Academy for the year 1733, there is a particular account of an experiment, in which Mercury is ſaid to have been extracted from Lead by diſſolving it in the nitrous acid: During the diſſolution, there fell a Precipitate, which is plainly proved to be Mercury, and which is looked upon as one of the conſtituent principles of the Lead, ſeparated by this ſimple proceſs. Probably Aqua fortis made uſe of in this experiment had been impregnated with Quickſilver: In ſuch caſe the Mercury precipitates in proportion as the Lead diſſolves; but pure Lead, diſſolved in pure Aqua fortis, gives no ſuch Precipitate.

Spirit of common Salt, concentrated or diluted, has little or no effect upon Lead by moderate digeſtion. On raiſing the fire, ſo as to make the liquor boil and diſtill, the Lead retains a portion of the acid, and is corroded into a ſaline maſs, ſoluble, by a repetition of the proceſs, into a limpid liquor. When Lead is precipitated from Aqua fortis by Sea-ſalt or its acid, an addition of Aqua regia rediſſolves the calx, and Sea-ſalt no longer occaſions any precipitation.

Oil of Vitriol, aſſiſted by a boiling heat, corrodes about half its weight of Lead into a ſaline maſs. This acid, added to ſolutions of Lead made in either of the others, imbibes the metal from them, and forms with it an indiſſoluble concrete which falls to the bottom.

Cauſtic alcaline lixivia, boiled on plates of Lead, diſſolve a ſmall portion, and corrode a conſiderable quantity: The ſolution ſtains hair black. Lead fuſed with fixed alcaline Salts is in part corroded into a dark coloured ſcoria, which partially diſſolves in water.

Expreſſed Oils diſſolve calces of Lead, by boiling, in ſuch large quantity as to become thick or conſiſtent: Hence plaſters, cements for water-works, paint for preſerving nets, &c.

Acids have a greater affinity with Lead than Oils have. If the common plaſter, compoſed of oil and Litharge, be boiled in diſtilled Vinegar, the Litharge will be diſſolved, and the oil thrown up to the ſurface. The oil thus recovered, proves ſoluble, like eſſential oils, in Spirit of Wine; a phœnomenon firſt taken notice of by Mr. Geoffroy.

LEAD.

Vegetable acids diſſolve Lead in its metallic ſtate very difficultly and ſparingly; its calces more readily, though the quantity of theſe taken up is very ſmall. A dram of Litharge requires for its ſolution eight ounces of diſtilled Vinegar, and a dram of Minium as much again: Out of a dram of Lead itſelf, two pounds of Vinegar will hardly diſſolve a ſcruple. The ſolution is of a ſweet taſte; and if duly evaporated, and ſet in a warm place, that the remaining moiſture may ſlowly exhale, yields cryſtals called from their ſweetneſs, *Saccharum Saturni*, Sugar of Lead.

Solution in Vinegar.

Saccharum Saturni.

On diſtilling the *Saccharum Saturni* in a retort, there ariſes an inflammable ſpirit, which is ſuppoſed to be Spirit of Wine reſuſcitated from the Vinegar; though it has not the taſte of vinous ſpirits: This is followed by a thin yellowiſh oil, and a thicker red one, eſpecially if the *Saccharum* has been made with undiſtilled Vinegar. From twelve ounces of the Sugar were obtained three and a half of oily liquor: The reſiduum weighed eight ounces and a half, and yielded on reduction ſeven and a half of Lead. Libavius and others pretend that an inflammable ſpirit may be obtained from a ſolution of Lead in the vitriolic acid diluted with water, filtered and inſpiſſated: But though the experiment was often with great care repeated and varied, no inflammable liquor was produced.

Lead is employed for various mechanic uſes; as in thin ſheets for covering buildings, for pipes, ſtatues, ſhot and bullets, windows, for ſecuring iron-bars in hard ſtones, for ſundry kinds of large veſſels for evaporation, *&c.* It has been obſerved that plants do not thrive ſo well in leaden, as in earthen and wooden veſſels——Its principal uſes in the chemical arts are, for promoting the vitrification of earthy and ſtony matters, in the making of Glaſs, or in the ſmelting of ores, or in the glazing of earthen veſſels; for the refining of Gold and Silver; for the eliquation of Silver from Copper; for forming with oil, the baſis of varniſhes and paints.

Uſes of Lead.

The effects of Lead on the human body are dangerous: Thoſe who are expoſed to its vapours in the fire, and even thoſe who grind its calces, Minium, Ceruſſe and Litharge, for the painters, are ſubject to violent gripes and conſtipations of the bowels, contractions of the limbs and other diſorders. Much more hurtful is the internal uſe of Lead corroded or diſſolved by acids, as *Ceruſſe*, *Saccharum Saturni*, the ſolution in Vinegar called *Acetum Lithargyrii*, or the tincture drawn from the *Saccharum* with Spirit of Wine commonly called *Tinctura Antiphthiſica*. The ſaturnine preparations are applied externally with ſafety, as coolers, repellents, and deſiccatives: Its calces, diſſolved in oils, form the baſis of moſt of the officinal plaſters.

Medical hiſtory of Lead.

Culinary veſſels, lined with a mixture of Tin and Lead, which is the uſual tinning, are apt to communicate to acid foods pernicious qualities, and require to be uſed with great precaution—In Holland, and perhaps in other places, it has been cuſtomary to correct the more offenſive expreſſed Oils, as that of rapeſeed, ſo as to ſubſtitute them to oil Olive or oil of Almonds, by impregnating them with Lead: This dangerous abuſe may be diſcovered, by mixing a little of the ſuſpected oil with a ſolution of Orpiment made in Lime-water: On ſhaking them together, and ſuffering them to reſt, the oil, if it has any ſaturnine taint, will appear of an orange-red colour; if pure, of a pale yellowiſh——

Method of diſcovering Lead in liquors.

LEAD. The ſame abuſe has been extended alſo to acid wines, which diſſolve ſo much Lead as to acquire a ſweet taſte, and to become ſlow poiſons. The Lead is readily diſcovered in theſe likewiſe by the ſame ſulphureous ſolution; which changes the colour of wines impregnated with this metal to a browniſh red or a blackiſh; Lead, whether diſſolved or in its metallic form, being conſtantly ſtained by ſulphureous liquors or vapours.

Lead is ſometimes found in the earth native or in its metallic form, though very rarely pure. Its common ores are nearly of the colour of Lead itſelf, and appear compoſed of cubes or parallelopipeds, ſometimes large and regular, ſometimes irregular and ſmall. There are Lead ores alſo of a white, greyiſh, or greeniſh colour, and priſmatic figure; but theſe are rarely met with. (*p*) The ores of Silver, Copper, and other metals except Tin and Iron, have often a Lead ore intermixed. The Lead is extracted by fuſion in contact with the fuel: The furnace being ſufficiently heated with wood or charcoal, the powdered ore is thrown in by degrees, and freſh fuel and ore occaſionally ſupplied: The Lead, revived by the inflammable matter of the coals, runs down into a baſon at the bottom of the furnace; from whence it is laded out, and caſt in Iron moulds, into large maſſes called pigs of Lead. All the common Lead ores contain ſome Silver: The ſteel-grained and ſuch as are compoſed of ſmall cubes, have generally more Silver than the compact and large-diced ſorts: The white and green ſcarcely hold any. The Silver is extracted, when its quantity is conſiderable enough to bear the expence of extracting it, by ſcorifying the Lead upon a teſt: The whole being kept in fuſion on a hearth made of bone-aſh or other like materials, the Lead partly vitrifies and ſinks into the hearth, and partly turns to Litharge which floats on the ſurface and is raked or blown by bellows to one ſide; the Silver at length remaining by itſelf.

(*p*) *Lead Ores.*] Lead is exceeding rarely, if ever, found native in the earth: The maſſes, which have been taken for native Lead, appear, upon due examination, to be the malleable leaden coloured ores of Silver—The common Lead ores conſiſt of Lead in the ſtate of a calx, blended with Sulphur: Minium, Litharge, or other calces of Lead, melted with Sulphur, form a compound ſimilar to them both in appearance and quality.

The ores of Lead ſoften, in a moderate red heat, into the conſiſtence of a paſte, but do not flow thin in a ſtrong fire: If Iron filings are mixed, the Iron abſorbs the Sulphur, and at the ſame time revives the Lead into its metallic form. This is one of the moſt commodious methods of ſmelting Lead ores, where the operation is performed in veſſels. Mr. Scheffer informs us, that the Lead ores at Dal in Sweden, containing from twenty to twenty-five ounces of Silver on the hundred pounds, are ſmelted by this method, in crucibles, without any loſs of the Silver; and that the produce of Lead is greater than that obtained by other means. The aſſayers generally calcine the ore, to diſſipate the Sulphur, and then melt it with twice or thrice its weight of black flux; ſuſpecting, that as the ſcoria, when only Iron is uſed, does not melt, a little of the Lead may be retained in it. The yield of Lead is from about one third to upwards of two thirds of the weight of the ore; according as it is leſs or more free from ſpar or other heterogeneous earthy matters.

The white or greyiſh, and the yellowiſh green ores are very rarely met with, and their compoſition is little known. They are very ponderous, and very rich in metal: On barely expoſing them to the flame of a candle, the Lead quickly and plentifully melts out. They are ſometimes cryſtalline and ſemitranſparent; ſometimes opake, and little different in appearance from common ſtones.

itſelf. Lead almoſt always contains ſome portion of Copper; and hence the Silver obtained in this operation is ſcarcely ever free from ſome admixture of that metal: If the pureſt Silver be cupelled or teſted with Lead, it will gain from the Lead a venereal taint; a ſmall proportion of Copper being defended by the Silver from ſcorifying along with the Lead (*q*). LEAD.

II. COPPER.

COPPER, *Venus*, is a reddiſh metal, eaſily tarniſhing in a moiſt air, and contracting a green or a bluiſh green ruſt. It is the moſt elaſtic and ſonorous of all the metals, and the hardeſt of all but Iron (*r*). It ſpreads difficultly under the hammer, but may be extended to a great degree; drawn into fine wire, and beat into thin leaves. Its ſpecific gravity is near nine times greater than that of water. COPPER. General characters.

It requires for its fuſion a ſtrong white heat; greater than that in which Gold and Silver melt, though not ſo great as that which is requiſite for the fuſion of Iron (*s*). When melted, it is remarkably impatient of moiſture: The contact of a little water occaſions the melted Copper to be thrown about with violence, to the great danger of the by-ſtanders. It may nevertheleſs be granulated, Fuſion.

(*q*) *Lead contains*, &c.] Almoſt all the common ſorts of Lead contain a portion of Silver, too inconſiderable to be extracted to any advantage, but large enough to deſerve attention in the nicer chemical experiments. In aſſaying particularly, where Lead is often employed in eight, ten, twelve, or more times the quantity of the ore or metallic mixt to be examined, its purity from the precious metals is of primary conſequence; leſt we aſcribe to the ore, the Silver furniſhed by the ſuperadded Lead. For the greater certainty in this point, the Lead is aſſayed ſeparately: Thus, when a Silver ore is to be ſcorified by Lead, an equal quantity of the ſame Lead is at the ſame time ſcorified by itſelf; and the weight of the button of Silver, left by the Lead, deducted from that left by the ore and Lead.

Lead, revived from perfect Litharge, is pure from the precious metals; theſe metals not being convertible with it into that form. Litharge diſſolves in Aqua fortis, and is precipitated by oil of Vitriol; and in theſe properties differs from all other metallic calces. Hence by edulcorating the Precipitate with freſh parcels of boiling water, and reviving it with inflammable fluxes, we obtain Lead perfectly pure from all other known bodies.

(*r*) *Copper—hard*, &c.] Copper in ſome of its ſtates is as difficultly extended under the hammer as Iron, but proves ſofter to the file; and is never found hard enough to ſtrike a ſpark with Flint or other ſtones; whence its uſe for chiſels, hammers, hoops, *&c.* in the gun-powder works. Broke, by often bending backwards and forwards, it appears internally, of a dull red colour without any conſiderable brightneſs, and of a fine granulated texture; not ill reſembling, as Cramer obſerves, ſome kinds of earthen ware. The ſpecific gravity of the fineſt Copper I have been able to procure, turned out to that of water as 8,830 to 1,000.

(*s*) *Copper in the fire.*] Copper continues malleable when heated red, and in this ſtate extends more eaſily than when cold. In this reſpect it agrees with Iron; but it wants that valuable quality of Iron, by which two pieces cohere when heated, ſo as to be welded or joined into one. When in fuſion, it appears on the ſurface of a bluiſh-green colour, nearly like that of melted Gold. Kept in fuſion for a length of time, it becomes gradually more and more brittle, but does not ſcorify conſiderably, nor loſe much of its weight. It is much leſs deſtructible than any of the other imperfect metals, and is very difficultly ſubdued even by Lead or Biſmuth.

COPPER. granulated, like other metals, by cautiouſly pouring a very little at a time into water (*t*).

Calcination. Kept in a heat below fuſion, it contracts on the ſurface thin powdery ſcales, which, if rubbed off, are ſucceeded by freſh ones, till the whole quantity of

Vitrification. the metal is thus ſlowly changed into a dark reddiſh ſcoria or calx. This does not melt in the greateſt degree of fire that our furnaces are capable of giving; but in the concentrated ſolar heat, it runs eaſily into a deep red and almoſt opake Glaſs. A flaming fire, and a ſtrong draught of air over the ſurface of the metal, promote its calcination: The flame being tinged of a green, bluiſh, or rainbow colours, is a mark that the Copper burns.

Solubility in different liquors. Copper diſſolves in every acid, in alcalies both fixed and volatile, in neutral ſaline liquors, and in oils; and when diſſolved, exhibits fine blue, green, or bluiſh-green colours, by which this metal is readily diſtinguiſhed however mixed or diſguiſed with other ſubſtances (*u*.) Even pure water, ſuffered to ſtand long in copper-veſſels, extracts ſo much as to gain a coppery taſte: It is obſervable, that water becomes more impregnated with the taſte on ſtanding in the cold, than if boiled in the veſſel for a longer time (*x*).

Phœnomena in treating it with different acids. The nitrous acid diſſolves Copper the moſt readily and plentifully: The ſolution is of a green colour.

The marine acid acts more languidly (*y*): The ſolution made in this acid yields on being inſpiſſated, a greeniſh maſs, which readily diſſolves in water, deliquiates in the air, gives a green tincture to rectified Spirit of Wine, melts in a ſmall heat, takes fire from a candle, and burns with a blue flame. The marine

(*t*) *Granulation.*] Copper is ſaid to be granulated in the braſs-works at Briſtol, without exploſion or danger, by letting it fall, in little drops, into a large ciſtern of cold water covered with a braſs-plate: In the middle of the plate is an aperture, in which is ſecured, with Sturbridge clay, a ſmall veſſel, whoſe capacity is not above a ſpoonful, perforated with a number of minute holes, through which the melted Copper paſſes. A ſtream of cold water is kept conſtantly running through the ciſtern: If ſuffered to grow hot, the Copper falls liquid to the bottom, and runs into plates.

(*u*) *Diſtinguiſhed by its colour in ſolution.*] The colour of Copper is moſt conſpicuous with volatile alcaline ſpirits. Solutions made in acids, when conſiderably diluted, have little colour: The addition of volatile ſpirits to the almoſt colourleſs liquor renders it inſtantly of a deep blue. The hundredth part of a grain of Copper, diſſolved in a pint of liquor, ſtrikes a ſenſible blue with volatile alcalies.

(*x*) *Corroded more by cold than by boiling water.*] The caſe ſeems to be the ſame in regard to the mild vegetable acids. The confectioners prepare the moſt acid ſyrups, even thoſe of Orange and Lemon-juice, by boiling in clean copper veſſels, without the preparations receiving any ill taſte from the metal; whereas either the juices themſelves, or the ſyrups made from them, if kept cold in copper veſſels, ſoon become impregnated with a diſagreeable taſte, and with the pernicious qualities of the Copper.

(*y*) *Solution in the marine acid.*] This ſolution, if made without heat, appears at firſt brown, but on ſtanding for ſome time, depoſites a white ſediment, and becomes green: On adding freſh Copper, it turns brown again, and now recovers its greenneſs more ſlowly than at firſt. The white ſediment is not, as ſome ſuppoſe, a part of the metal deprived of its colouring principle: On being barely melted, it proves pure and perfect Copper, of the ſame red colour as at firſt——Copper, calcined by fire, communicates to this acid not a green but a reddiſh tincture.

marine acid forſakes Mercury to unite with Copper: On expoſing to the fire a mixture of Copper and Mercury-ſublimate, the acid of the Sublimate forms with the Copper a fuſible inflammable concrete ſimilar to the foregoing, whilſt the Mercury, diſengaged, diſtils in its running form. COPPER.

The vitriolic acid does not eaſily diſſolve Copper unleſs highly concentrated and aſſiſted by a conſiderable heat: The ſolution is of a blue colour, and on evaporating a part of the humidity, ſhoots into elegant blue cryſtals of a rhomboidal figure; theſe are the blue Vitriol of the ſhops. The ſolution is moſt commodiouſly obtained by drawing over the oil of Vitriol from the Copper, and elixating the reſiduum with water; then returning the diſtilled ſpirit upon the undiſſolved Copper, and repeating the abſtraction: Or by ſtratifying the Copper with Sulphur, in a crucible, and calcining or cementing them together; the Copper will abſorb the acid of the Sulphur, ſo as to become in part ſoluble in water, and yield the ſame cryſtals as if the metal had been boiled directly in the vitriolic acid.

Volatile alcalies, added to the ſolutions made in acids, occaſion at firſt ſome precipitation, but preſently rediſſolve what they had thrown down, and change the colour, from a green or a pale blue, to a deep and lovely blue: If the liquor is expoſed for a time to the air, the volatile alcali eſcapes, and the colour which proceeded from it diſappears. Volatile alcalies extract a blue tincture alſo from filings of the metal, without the intervention of any acid (z).

Vegetable acids diſſolve Copper ſlowly, but in conſiderable quantity: The ſolution ſhoots into bluiſh green cryſtals ſimilar to the Verdegris, *ærugo* or *viride æris*, of the ſhops. This preparation is made in large quantity in France, particularly about Montpelier, by ſtratifying copper-plates with the huſks of grapes remaining after the juice has been preſſed out: Theſe ſoon become acid, and corrode the Copper. Verdegris.

Verdegris ſhould be choſen in cakes, not moiſt or unctuous, but dry, compact and of an uniform texture, of a lively green colour throughout, as free as poſſible from white or black ſpecks, and ſeeds or ſtalks of the grape. It is purified by ſolution in diſtilled Vinegar, and cryſtallization; and then called, improperly, *diſtilled Verdegris* or *flowers of Copper:* The Dutch, who prepare theſe cryſtals in large quantity, after duly evaporating the ſolution, ſet it to ſhoot, not as is cuſtomary in a cold, but in a warm place, as practiſed for making Sugar-candy. If rectified Spirit of Wine be added to the ſolution, or if volatile alcalies be added to a ſolution of Copper and Spirit of Wine to this mixture,

(z) *Volatile alcalies.*] The blue mixture of ſolution of Copper in Aqua fortis with volatile ſpirits, yields ſapphire coloured cryſtals, which diſſolve in Spirit of Wine, and impart their colour to it. If, inſtead of cryſtallization, the liquor be totally evaporated; the remaining dry matter, explodes in a moderate heat, like Aurum Fulminans. The ſolution made in volatile alcalies, without the intervention of any acid, yields on evaporation a blue ſaline maſs, which, mixed with fats or other inflammable matters, tinges their flame green, leaving a red calx of Copper ſoluble in volatile ſpirits again as at firſt——Boyle obſerves that volatile ſpirits gain no tinge from Copper in vacuo: Whether it is the diſſolution of the metal, or only the colour, that does not ſucceed without air, has not been fully determined—Oil of Vitriol added to the blue ſolutions, deſtroys their colour: A freſh addition of volatile Alcali recovers it again.

COPPER. mixture, small blue crystals will be immediately formed: These are called by some antepileptic crystals of Copper.

Divers experiments on Verdegris.

Highly rectified Spirit of Wine, digested on half an ounce or twelve scruples of powdered Verdegris, dissolved three scruples and a half; ordinary rectified Spirit, four scruples; common Malt Spirits, four and a half; and French Brandy, seven and a half. Water dissolved, out of the same quantity, five scruples: Common Wine Vinegar dissolved all but fifteen grains; and distilled Vinegar, all but ten grains (*a*). The whole quantity of Verdegris dissolved in either kind of Vinegar, could not be recovered again in a crystalline form: From the common Vinegar, only two scruples and five grains crystallized, and from the distilled Vinegar three scruples: The residuum, in the first case continued softish, in the latter dry. With French Brandy, there was no crystallization at all; the whole that the spirit had taken up, remaining uniformly mixed, into the consistence of an extract.

Verdegris distilled in a retort, yields a concentrated acetous acid. Mr. Serane relates, that from sixteen ounces of crystallized Verdegris, he obtained three ounces of phlegm, and afterwards six ounces of strong spirit; that the brown powdery residuum weighed five ounces and a half, and yielded, on fusion with Borax, three ounces and six drams of Copper. Lancisi mentions also this experiment, and seems to have borrowed it from Serane, the quantities being exactly the same, except that only the drams of Copper are put down, the ounces being by mistake omitted. I repeated the process, with the same quantity of Verdegris, and gained four ounces of phlegm, two ounces of spirit of moderate strength, three ounces and six drams of strong spirit, and six ounces two drams of residuum.

The spirit thus obtained is no other than the concentrated acid of Vinegar: Zwelffer prepares a spirit which is said to be different. Crystallized Verdegris is reduced into gross powder, put into a glass retort with so much highly rectified Spirit of Wine as will cover it to the height of three or four fingers, the vinous spirit drawn off, and a fresh parcel returned two or three times: The remaining Verdegris is then distilled in a coated retort in an open fire, and the acid spirit which arises, rectified by a second distillation in a fresh retort. Boerhaave relates, that this spirit loses its acidity, in the same manner as other acids, when combined with alcalies or absorbents, and that the pure acid is never to be recovered again from those admixtures. Stahl on the other hand confirms Zwelffer's account, that this spirit differs from the common acetous acid in being recoverable from absorbent earths, as strong as at first; and this repeatedly for any number of times. My experiments have not as yet been carried far enough to determine this point: But it appears probable, that Boerhaave, instead of Zwelffer's spirit, employed common spirit of Verdegris. From four ounces of dried crystals of Verdegris I abstracted two parcels of highly rectified Spirit of Wine, and found that the Verdegris had then lost six drams of its weight: Being now distilled in an open fire gradually increased, it

(*a*) *Residuum of Verdegris.*] The matter which distilled Vinegar leaves undissolved, on being mixed with some Borax and Linseed-oil, and fluxed in a crucible, yields a brittle metallic substance, of a whitish colour not unlike bell-metal. What this metal really is, has not hitherto been examined.

it yielded one ounce, five drams and two ſcruples of ſpirit: The reſiduum weighed half an ounce and one ſcruple, and looked like Colcothar. The liquor which came over about the middle of the diſtillation, had a very volatile penetrating ſmell; and the ſtronger ſpirit fumed at times like the ſmoking mineral ſpirits. COPPER.

Quickſilver in its pure ſtate amalgamates very difficultly with Copper, but unites with it more eaſily if divided by certain admixtures. If Mercury and Verdegris be triturated together, with common Salt, Vinegar and water, the Copper in the Verdegris will be imbibed by the Mercury, and form with it, as Boyle obſerves, a curious amalgam, at firſt ſoft ſo as to receive any impreſſion, and which, on ſtanding, grows hard like brittle metals. Braſs leaf likewiſe gives out its Copper to Mercury, the other ingredient of the Braſs ſeparating in the form of powder (*b*). Amalgamation.

Copper is the baſis of ſundry compound metals for mechanic uſes; as Braſs, Princes-metal, Bell-metal, Bath-metal, white Copper, *&c.* Braſs is prepared from Copper and Calamine, with the addition of powdered Charcoal, cemented together, and at length brought into fuſion: Sixty-four pounds of Copper commonly imbibe in this proceſs twenty-ſix pounds from the Calamine, and yield ninety of Braſs: The paler the Braſs, the more of the Calamine it holds. This metal, notwithſtanding its large admixture of a brittle metallic body, continues ſtill remarkably ductile: It is drawn into the fineſt wire, for muſical inſtruments, *&c.* and beat into leaves in imitation of gold-leaf. The metallic part of the Calamine, which here unites with the Copper, appears to be Zinc: Hence Braſs, expoſed to the fire, flames like Zinc itſelf, and loſing by degrees that volatile ingredient, becomes Copper again (*c*). Princes-metal is made by melting Zinc in ſubſtance with Copper: And all the yellow compound metals, prepared Compound metals with Copper. Braſs. Princes-metal.

(*b*) *Amalgam of Copper.*] I have likewiſe obtained amalgams of Copper, by grinding Quickſilver, in an iron mortar, with a ſaturated ſolution of the metal in Aqua fortis; as alſo with the muddy ſubſtance procured in the poliſhing of copper-plates; and by cautiouſly pouring a ſmall quantity of melted Copper, in a ſlender ſtream, through a perforated iron plate, into a large portion of Quickſilver made almoſt boiling hot. The Copper, recovered from the amalgams, retained its original redneſs; and diſcovered no tendency to the yellow colour which Homberg reports that this metal acquires on being amalgamated and freed from the Mercury. Even when Braſs is uſed for making the amalgam, the recovered metal is perfect red Copper; the ingredient from which the Braſs received its yellowneſs being, as above obſerved, ſeparated in the amalgamation.

(*c*) *Braſs.*] The proportion of Calamine, and the increaſe which the Copper receives from it, are different at different works: Hence the deeper or paler colour of Braſs. I have obſerved, in a large ſet of experiments on this ſubject, that a little of the Calamine, (that is, of the Zinc contained in Calamine,) dilutes the colour of the Copper, and renders it pale; that when the Copper has imbibed about one twelfth its own weight, the colour inclines to yellow; that the yellowneſs increaſes more and more till the proportion comes almoſt to one half; that on further augmenting the Calamine, the Braſs becomes paler and paler, and at laſt white. The crucibles, in which the fuſion is performed in the large works, are commonly tinged by the matter of a deep blue colour.

Braſs is ſomewhat lighter, harder, and more ſonorous, than pure Copper. It melts more eaſily, and does not ſcorify ſo ſoon in a moderate red heat; and hence proves more convenient for ſundry ſorts of veſſels and

COPPER. prepared in imitation of Gold, are no other than mixtures of Copper with different proportions of that ſemi-metal taken either in its pure ſtate, or in its natural ore Calamine; with an addition ſometimes of iron filings, &c. Zinc itſelf unites moſt eaſily with the Copper, but Calamine makes the moſt ductile compound, and gives the yelloweſt colour. Bell-metal is a mixture of Copper and Tin: Though both theſe metals are malleable ſingly, the compound proves quite brittle (*d*). White Copper is prepared with Arſenic: Equal parts of Arſenic and Nitre, pulverized and mixed together, are injected into a red-hot crucible, and kept in a moderate fire, till they ſubſide and flow like wax: One part of this mixture is injected upon four parts of melted Copper, and the metal, as ſoon as they appear thoroughly united together, immediately poured out. The Copper thus whitened is commonly melted with a conſiderable proportion of Silver, by which its colour is both improved and rendered more permanent (*e*).

Bell-metal.

White Copper.

Uſe in painting, &c. Sundry preparations of Copper are employed in painting, ſtaining, and for colouring Glaſs and enamels (*f*). Verdegris makes a fine green both in oil and

and utenſils. It is ductile only whilſt cold: Heated a little, it cracks, ignited it falls in pieces under the hammer. This imperfection it receives from the Zinc; pure Copper being malleable when hot as well as when cold.

(*d*) *Copper with Tin.*] Copper is diſſolved by melted Tin, eaſily and intimately; far more ſo than by Lead. A ſmall portion of Tin renders Copper dull coloured, hard, and brittle: Bell-metal is compoſed of about ten parts of Copper to one of Tin, with the addition, commonly, of a little Braſs or Zinc. A ſmall portion of Copper, on the other hand, improves the colour and conſiſtence of Tin, without much injuring its ductility: Pewter is ſometimes made from one part of Copper and twenty or more of Tin.

It has long been obſerved, that though Tin is ſpecifically much lighter than Copper, yet the gravity of the compound, Bell-metal, is greater than that of Copper itſelf. I found the ſame augmentation of gravity alſo where the lighter metal was in greater proportion: A mixture even of one part of Tin with two of Copper turned out ſpecifically heavier than pure Copper.

From ſome experiments on other metals, which this remarkable phœnomenon gave occaſion to, it appeared that few metallic mixtures anſwer to the mean gravity of the ingredients, or ſuch as would reſult from a bare appoſition of part. Of thoſe that have been tried, ſome exceeded the mean, but the greater number fell ſhort of it: Copper and Tin were the only ones, that formed a compound heavier than the heavieſt of the metals ſeparately.

From theſe obſervations it is obvious, that Archimedes's propoſition, and the tables calculated on that principle in the *Commentaria Petropolitana*, &c. for determining the proportion of two metals in a given mixt by hydroſtatical experiments, are leſs to be depended on than has hitherto been ſuppoſed.

(*e*) *White Copper.*] The white Copper of China and Japan appears to be no other than a mixture of Copper and Arſenic. Geoffroy, relates, that on repeated fuſions, it exhaled arſenical fumes, and became red Copper; loſing, with its whiteneſs, one ſeventh of its weight—Copper is ſaid to be whitened alſo by cementation with the aſhes of Tartar imperfectly burnt: I have frequently cemented it with theſe, for different lengths of time; without being able to perceive the leaſt alteration in the colour of the Copper.

(*f*) *Staining, coloured Glaſs*, &c.] Solution of Copper in Aqua fortis ſtains Marble and ſome other ſtones of a green colour: Precipitated with Chalk or whiting, it yields the green and blue verditer of the painters. A ſolution made in volatile ſpirits ſtains ivory

and in water colours, inclining more or leſs to bluiſh: A ſolution of it in Aqua fortis, inſpiſſated, tinges Glaſs in fuſion of the ſame colour. In ſome parts of France, it is cuſtomary to mix Verdegris with Plaſter-of-Paris, which by this means is ſaid to become firmer and more durable. It is employed alſo in cements for heightening the colour of Gold: A mixture of Gold with one third, or even with half its weight of Silver is ſaid to acquire on cementation with Verdegris, the colour of pure Gold: See Gold. COPPER.

The medical uſe of Copper is entirely external: Verdegris, and blue Vitriol, are employed as mild eſcharotics, for cleanſing fiſtulous ulcers, and other like purpoſes. Internally, all the preparations of this metal are extremely dangerous: Examples are too frequent of fatal conſequences from eating food that had received a taint from copper-veſſels; whether from the food itſelf being of an acid nature ſo as to corrode or diſſolve a portion of the metal; or from the veſſel having contracted a ſoluble ruſt or Verdegris by lying in the air: The utmoſt caution is therefore requiſite in the uſe of copper-veſſels, and even of Silver ones that are largely alloyed with Copper. I knew a perſon, who having accidentally ſwallowed a braſs ſleeve-button, was ſeized with violent ſymptoms, and died in miſery; no medicines giving relief. I have known vehement vomitings, and even convulſions, in children, from the *unguentum ægyptiacum*, whoſe baſis is Verdegris, applied to ulcers in the mouth: When employed in this intention, as it commonly is, the patient muſt be well upon his guard againſt any of it paſſing down. Medical Hiſtory.

Copper is exceeding rarely found pure in the earth. Of its ores there is a great variety, intermixed with different ſtony matters, generally abounding with Sulphur, ſometimes containing a little Arſenic. Theſe ores are often of beautiful colours, blue, red, green, yellow, variegated like the rainbow or peacock's tail, moſt commonly green or blue: They are of all ores the moſt beautiful. The Lapis Lazuli, from which the precious blue pigment called Ultramarine is prepared, is one of the ores of this metal. Some of them contain no metal but Copper; many have an admixture of others; and there are few ores of other metals without ſome portion of Copper in them. Copper is of all metals the moſt difficultly obtained pure from the ore; Sulphur adhering to it ſo ſtrongly, as not to be expelled without long calcination. When Copper and Iron are blended together in the ore, the Copper cannot by any method Natural Hiſtory.

ivory and bones, macerated for ſome time in the liquor, of a blue colour, at firſt ſufficiently beautiful, but which tarniſhes in the air, and becomes green. I know of no method of obtaining by art a permanent blue from Copper, but by vitrification. I have prepared elegant deep blue glaſſes by melting common Glaſs, or compoſitions of powdered Flint and fixed alcaline Salt, with Verdegris, with blue Vitriol, and with an amalgam of Copper; fine green ones, with green Verditer, with blue Verditer, with a Precipitate of Copper made by fixed alcalies, and a Precipitate by Zinc; and a reddiſh Glaſs, with calx or ſcoria of Copper made by fire alone: Even in this vitreous ſtate however, it ſeems as if a continuance of fire had the ſame effect, in regard to colour, as air has upon Copper in other forms: Some of the moſt beautiful blue glaſſes, by continued fuſion, changed to a green.

COPPER. method as yet known, be ſeparated to advantage: A rich Copper-mine, at Lauterberg in the Hartz foreſt, lies on this account unworked.

There are ores of Copper in almoſt all parts of the world; in Spain, France, England, Norway Saxony, Bohemia; but more particularly in Sweden, Hungary, and Tranſylvania. Japan affords a ſort of Copper, ſuperior to any met with in Europe.

Copper is found alſo in a vitriolic ſtate, diſſolved in certain waters, as at Neuſol in Hungary: When Iron is put into the water, the diſſolved Copper ſeparates; a proportionable quantity of the Iron being diſſolved in its place. The Copper, extricated from the liquor, adheres to the Iron, and covers its ſurface with a bright cupreous coat: Some have been ſo far impoſed on, as to imagine the Iron, by this means, actually tranſmuted into Copper.

III. IRON.

IRON. IRON, *Mars*, is a greyiſh metal, ſoon tarniſhing in the air to a duſky blackiſh hue, and in no long time contracting a yellowiſh or reddiſh ruſt.

Its general characters. It is the moſt ſonorous of the metals except Copper; the hardeſt and moſt elaſtic of them all; hence its excellence for mechanic inſtruments: It is made into tools, by which all the others are filed, drilled, and cut; and is the only one that ſtrikes ſparks with Flint. It ſpreads difficultly under the hammer, but may be extended to a great degree, drawn into wire as ſlender as the fineſt hairs: It is more eaſily malleable when ignited than when cold; whilſt ſome of the other metals, though ductile when cold, become quite brittle by heat. It is lighter, conſiderably, than Copper; and a little heavier than Tin. It is the only metallic body, which attracts, or is attracted by, the magnet, one of its own ores.

Igneſcibility, Iron grows red-hot much ſooner than any other metal, and this not only from the application of actual fire, but likewiſe from ſtrong hammering,

Fuſibility, friction, or other mechanic violence. It nevertheleſs melts the moſt difficultly of all the metals; requiring, in its moſt fuſible ſtates, an intenſe bright white heat. When perfectly malleable, it is not fuſible at all, without additions, or the immediate contact of the burning fuel; and when melted, it loſes its malleability: All the common operations which communicate one of theſe qualities, deprive it at the ſame time of the other, as if fuſibility and malleability were in this metal incompatible.

Calcination, Expoſed to a white heat, inſufficient for its fuſion, it contracts a ſemivitreous coat, which burſts at times, and flies off in ſparkles: No other metallic body exhibits any ſuch appearance (*g*). On continuing the fire, it changes by degrees

(*g*) *Iron, phœnomena from fire.*] The contact of cold liquors occaſions Iron to ſcale in a ſmall degree of heat: Hence its unfitneſs for boilers in ſuch works as require them to be emptied and charged again whilſt hot.

It does not tinge the flame of burning matters bluiſh or greeniſh, like the other imperfect metals, but brightens and whitens it: Hence the uſe of Iron filings in the compoſitions for fire-works, called white fire.

Strongly heated, it appears covered on the ſurface with a ſoft vitreous matter like varniſh:

grees into a dark red calx, which does not melt in the moſt vehement heat procurable in the furnace of the chemiſt, and which if brought into fuſion by additions, yields an opake black glaſs. Glaſs made from Iron, by whatever means, is always black, unleſs the quantity of vitreous matter mixed with it, be very large (*b*): The calces made by acids and by fire, are of various ſhades of yellow, brown, and red. IRON. Vitrification.

Iron

varniſh: In this ſtate, pieces of it cohere, and on being hammered together, weld or unite, without diſcovering a juncture. As Iron is the only metal, which exhibits this appearance in the fire, it is likewiſe the only one capable of being welded. Thoſe operations, which prevent the ſuperficial ſcorification, deprive it of this valuable property; which may be reſtored again by ſuffering the Iron to reſume its vitreous aſpect, and in ſome meaſure, by the interpoſition of foreign vitreſcible matters; whilſt none of the other metals will in any degree unite even with its own ſcoria.

Iron expands the leaſt of the metals by heat. In the act of fuſion, inſtead of continuing to expand, like the other metals, it ſhrinks; and thus becomes ſo much more denſe, as to throw up ſuch part as is unmelted, to the ſurface; whilſt pieces of Gold, Silver, Copper, Lead, Tin, put in the reſpective metals in fuſion, ſink freely to the bottom. In its return to a conſiſtent ſtate, inſtead of ſhrinking like the other metals, it expands; ſenſibly riſing in the veſſel and aſſuming a convex ſurface, whilſt the others ſubſide and appear concave. This property of Iron, firſt taken notice of by Mr. Reaumur, excellently fits it for receiving impreſſions from moulds: By the increaſe of bulk, which the fluid metal acquires in its congelation, it is forced into the minuteſt cavities, ſo as to take the figure far more perfectly than the other metals which ſhrink. The workmen have often obſerved, that Iron, though poured quite thick into the mould, has nevertheleſs received its impreſſion in perfection; and have wondered to ſee figures of caſt Iron larger than the mould, whilſt thoſe of other metals are leſs.

Iron with other metallic bodies.] Iron is diſſolved by all the metals made fluid by ſufficient heat, except Lead; on which it floats diſtinct, as oil upon water: Gold, of all metals, acts on it the moſt powerfully; though, as Cramer obſerves, if the Iron contains any portion of Sulphur, it can ſcarcely be made to unite at all with Gold.

Among the ſemi-metallic bodies, it is averſe to any union with Mercury: No method has hitherto been diſcovered of amalgamating Iron; though Quickſilver, in certain circumſtances, ſeems in ſome ſmall degree to act upon it. A plate of tough Iron, kept immerſed in Mercury for ſome days, becomes brittle: And I have often obſerved Mercury adhere to and coat the ends of iron peſtles uſed in triturating certain amalgams with ſaline liquors.

Next to Mercury, Zinc is the moſt difficultly combined with it; not from any natural indiſpoſition to unite, but from the Zinc being difficultly made to ſuſtain the due degree of heat: The mixture is hard, ſomewhat malleable, of a white colour approaching to that of Silver. Regulus of Antimony, as ſoon as it melts, begins to act on Iron, and diſſolves a conſiderable quantity: If the Regulus be ſtirred, in fuſion with an iron rod, it will melt off a part of the Iron. Arſenic likewiſe mingles eaſily with Iron, and diſcovers a great attraction to it, forſaking all the other metals to unite with this: It renders the Iron white, very hard, and brittle.

(*b*) *Iron with vitreous matters.*] The colours which Iron imparts to Glaſs in fuſion, are various and inconſtant. Vitrified without addition, by the concentrated ſolar heat, it is ſaid to be bluiſh or purpliſh: Scorified in our furnaces, it appears of a back or dark brown, and communicates the ſame duſky hue to three or four times its quantity of colourleſs Glaſs. Its ſeveral calces, fuſed with much larger proportions of vitreous matters, impart different ſhades of yellow, reddiſh, green and blue. Practical writers in general ſpeak of one preparation giving one colour; and another, others. From ſuch experiments as I have made in this view,

IRON.

Exposed to a burning-glass.

Iron placed in the focus of Tschirnhaus's large burning-glass, melts in an instant, and looks like a black Bitumen or Pitch: The French academicians concluded from hence, that the inflammable principle of Iron was an actual bituminous matter: But no experiment gives any just foundation for this conjecture: The pretended Bitumen is no other than vitrified Iron; and Iron calcined or vitrified, that is deprived of its own phlogiston, is revived into Iron again by any vegetable or animal coal, in the same manner as the other metals.

Solubility in different liquors.

Iron dissolves easily in all acids; it is likewise sensibly acted upon by alcaline and neutral liquors, and corroded even by those which have no perceptible saline impregnation: Strongly heated, and quenched in water, it communicates a manifest taste to the liquor: The filings exposed to the air, and occasionally moistened with water, soon change into rust. Even the oils, with which Iron utensils are often rubbed to prevent their rusting, in some measure contribute to promote that effect. Some employ, with better success, oil that has been gently boiled for a time; cautiously pouring into the oil, towards the end of the boiling, some melted Lead: The oil is by this means freed from its watery phlegm, and from its acid principle, which are the cause of its promoting the corrosion of the metal. Animal fats are said to answer still better; these being void of the least degree of acidity. Homberg's salve for preserving Iron from rust, communicated to the French academy, consists of two pounds of hog's Lard, an ounce of Camphor, and as much black Lead as will render the mixture of an iron colour: The Iron is to be heated, before it is anointed with this composition (*i*).

Preservation from rust.

Solution in vitriolic acid, inflammable vapour:

The vitriolic acid requires to be diluted with three or four times its quantity of water, to enable it effectually to dissolve Iron. During the dissolution, a strong sulphureous vapour arises, which on the approach of a candle, takes fire (*k*). The solution is of a grass green colour: On standing, it gradually

view, the colour seems to be influenced more by the degree and continuance of the fire, and other circumstances in the process, than by the particular manner in which the Iron is prepared. With the officinal flowers of Steel I have made a yellow and a greenish Glass; with the matter which remains after the sublimation of the flowers, a yellow, a green, and a blue: without being able to determine the particular circumstances in which either of these colours might with certainty be produced. One of the bluish green glasses, on being melted a second time, lost its bluish cast, and became of a deeper green than at first: After a third fusion, it looked green, yellow and red in different parts of the mass. With the calx made by long reverberation, I obtained a red but an ill-coloured Glass; not the lovely one which Kunckel promises: A piece of this Glass kept long in fusion, discovered a tendency to blueness.

(*i*) *Preserved from rust.*] Mr. Reaumur has discovered a composition which appears superior to all the foregoing. Expressed Oils, exposed to the air in flat shallow vessels so as just to cover the bottom, become thick, without losing their transparency, or acquiring any brown or other colour, which they always do when thickened by boiling. The inspissated Oil, skilfully mixed with a solution of Copal in Spirit of Wine, forms an elegant hard varnish. Polished Iron, made a little hotter than the hand can bear, and rubbed with a stick of this varnish, appears, as soon as cold, covered with a solid, thin, transparent coat, without the least injury to its colour or appearance.

(*k*) *Inflammable vapour.*] This vapour is permanent and elastic, and seems to have a great

gradually depoſites great part of the Iron in form of a yellow or reddiſh calx or ochre: Duly evaporated, it ſhoots into rhomboidal cryſtals, which are the green Vitriol, or ſalt of Steel, of the ſhops——The calx precipitated from this ſolution by fixed alcaline ſalts, is exceeding difficultly reducible into its metallic ſtate.

In the nitrous acid: The nitrous acid undiluted, acts violently on Iron, corrodes it plentifully, but diſſolves little; and what has thus once been corroded, will not diſſolve in freſh acid. If the acid has been diluted at firſt with water, it takes up a conſiderable proportion, provided the metal be leiſurely added. If the ſolution is performed with extreme ſlowneſs, the colour will be green; if otherwiſe, of a dark red. It does not cryſtallize; and if inſpiſſated to dryneſs, deliquiates in the air.

In the marine acid, volatilized: The marine acid acts leſs vehemently on Iron than the nitrous, and does not diſſolve ſo much. The ſolution is of a ſaffron or gold yellow colour: It does not cryſtallize; and if inſpiſſated, leaves a greeniſh ſaline maſs, which diſſolves not only in water but likewiſe in Spirit of Wine, and runs in the air into a yellow liquor: In diſtillation, a conſiderable portion of the Iron is volatilized (*l*). Ammoniacal Salts likewiſe, compoſed of the marine acid and volatile alcalies, elevate ſo much of this metal in ſublimation, as to receive from it a deep orange colour. This preparation is kept in the ſhops under the name of *flores martiales*, *Sal ammoniacum martiale*, or *mars diaphoreticus:* It is commonly made from one part of clean filings of Iron, and two of Sal Ammoniac, well mixed together, and ſublimed: A little urinous ſpirit ariſes before the yellow flowers, and generally a little marine acid after them. The reſiduum, ſet in a cellar, runs into a liquor ſimilar to that made with Spirit of Salt directly; called *liquor martialis*, or *liquamen martis*.

With vegetable acids. Vegetable acids, even wines that are but ſlightly acidulous, diſſolve a conſiderable quantity of Iron into a reddiſh liquor. The purer acids, as diſtilled Vinegar, by proper management, cryſtallize with it——Fixt alcaline Lixivia ſeem to have little effect upon Iron in its metallic ſtate: But if a ſolution of Iron, made in the nitrous acid, be dropt into a ſaturated lixivium, the Iron remains permanently diſſolved in the alcali: The liquor appears at firſt of a yellowiſh red colour; when loaded with the Iron, of a deep blood-red. Here the

Solution in alcalies.

great analogy to the inflammable damps in mines. It may be collected and preſerved in bladders; which being applied to the mouth of the veſſel, wherein the diſſolution is made, will ſoon be filled and diſtended by it. After keeping for ſeveral weeks, a little of the vapour, forced out near a candle, inſtantly took flame as at firſt.

(*l*) *Iron volatilized by Spirit of Salt.*] The ſpirit which diſtils towards the end of the proceſs appears yellow: This is followed by a yellowiſh or deep reddiſh Sublimate, which gliſtens like the ſcales of fiſhes; leaving behind a ſubſtance which conſiſts of thin gloſſy plates like Talc.

Iron with other metallic ſolutions.] Iron precipitates from acids all metallic ſubſtances except Zinc, and the newly diſcovered ſemimetals Regulus of Cobalt and Nickel—By ſolutions of Copper in acids, the Iron is ſtained of a copper colour; the Copper being extricated from its menſtruum in its metallic form, and adhering to the ſurface of the Iron. By ſolutions of Gold combined with rectified Spirit of Wine, it is in like manner covered with a golden coat: The preparation of Gold, ſaid to anſwer beſt for this purpoſe, is a Tincture drawn from a mixture of Gold-leaf, Sea-ſalt, and Alum, melted together, or boiled in water to dryneſs.

IRON. the acid ſerves only as a medium of union betwixt the Iron and the Alcali, and after the union is once effected, has no ſhare in the continuance of it; the acid forming, with a part of the alcaline Salt a true Nitre, which may be ſeparated from the martial ſolution by cryſtallization—— Much has been ſaid in books, of preparations of Iron that fulminate in the fire: I have made numerous trials for obtaining the *Mars fulminans*, without being ever able to ſucceed.

Uſes in ſtaining and dying. Solutions of Iron made in acids give a yellow ſtain to linen, *&c.* and ſtrike a black colour with galls and other vegetable aſtringents (*m*). Theſe are very valuable properties of Iron to the callico-printer, the ſtainer of leather, wood, *&c.* and the dyer. For linen and leather, the metal is commonly diſſolved in ſour whey or ſmall-beer; for dying, the Vitriol is made uſe of, (ſee Vitriol). This metal affords alſo, in its calces, red and yellow

Pigments. pigments to the painter; and a fine blue in the preparation called, from the place where it was firſt diſcovered, Berlin or Pruſſian blue——(*n*) A ſlight ſolution of Vitriol has been employed by ſome as an aſſay liquor for diſtinguiſhing

(*m*) *Black with vegetable aſtringents.*] This property of Iron affords a commodious method of diſtinguiſhing minute portions of it in mineral waters or other liquors. A ſingle grain of Vitriol of Iron, diſſolved in a gallon of water, inſtantly diſcovers itſelf, on adding a little powdered Galls, by a duſky blue colour. A more ſaturated ſolution of the Vitriol ſtrikes with galls a deep black colour; and this black mixture, diluted, appears blue like the former. If the liquor is impregnated with a minute portion of alcaline Salt, fixed or volatile, inſtead of a blue or blackiſh, a purpliſh red tincture is produced: This is the colour which Chalybeate mineral waters ſtrike with galls.

As it is only with vegetable aſtringents, that Chalybeate ſolutions ſtrike a blue or a black colour; theſe liquors have been employed as a teſt of aſtringency in vegetable ſubſtances. I have obſerved, however, that ſome vegetables, manifeſtly and powerfully aſtringent, do not exhibit this phœnomenon; their aſtringency reſiding in a principle not diſſoluble in watery liquors, and not miſcible with the vitriolic ſolution. The reſinous aſtringent, Peruvian bark, mixed with ſolution of Vitriol, in ſmall or in large proportions, in the form of powder, infuſion, decoction, extract, vinous or ſpirituous tincture, gives not a blue or a black, but a green colour, which with certain proportions is very deep and bright.

(*n*) *Pruſſian blue.*] Pruſſian blue is prepared by precipitating a ſolution of green Vitriol and Alum with a Lixivium drawn from fixt alcaline Salt that has been calcined with animal coals. Commonly about three parts of Alcali and two of dried ox blood are calcined ſo long as any flame appears, then thrown into boiling water, and the ſtrained decoction poured into a hot mixture of ſolutions of four parts of Alum and one or leſs of Vitriol. The liquor becomes inſtantly thick or curdly, and looks at firſt of a greyiſh colour, which changes to a brown, and in a little time to a bluiſh green. The matter being well ſtirred together, and mixed with a quantity of hard ſpring-water, a green precipitate ſubſides: Spirit of Salt poured upon the edulcorated powder, diſſolves a part, and leaves the reſt blue.

Mr. Geoffroy is the firſt who has given any plauſible theory of this proceſs, or any rational means for improving it. He obſerves, that the Pruſſian blue is no other than the Iron of the Vitriol, revived by the inflammable matter of the alcaline Lixivium, and perhaps brightened by an admixture of the white earth of the Alum; that the green colour proceeds from a part of the yellow ferrugineous calx or ochre unrevived, mixing with the blue; and that the Spirit of Salt diſſolves this ochre more readily than the blue part, though it will diſſolve that alſo by long ſtanding, or if uſed in too large quantity. From theſe principles he was led to increaſe the quantity of inflam-

ing French brandies from common ſpirits prepared in imitation of them; French brandy having uſually an aſtringent impregnation from the oaken caſks in which it has been kept, and hence ſtriking a bluiſh or black colour with the Chalybeate ſolution; whilſt ſpirits tinctured only with melaſſes, burnt ſugar, &c. give no ſuch colour. The principle, on which the blue colour depends, ſhews that it is no certain teſt: All ſpirits will exhibit it if impregnated with aſtringents; and French brandies will not, without ſuch impregnation.

Iron deflagrates with Nitre, and renders the Salt alcaline and cauſtic (*o*). It readily unites with Sulphur; and when combined with it, like the other refractory metals, proves much eaſier of fuſion than by itſelf. A mixture of Sulphur and Iron filings, moiſtened with water and preſſed down cloſe, in a few hours ſwells

Treated with Nitre, and Sulphur.

Artificial earthquakes.

inflammable matter, that there might be enough to revive the whole of the ferruginous ochre, and produce a blue colour at once without the uſe of the acid ſpirit: In this he perfectly ſucceeded, and found at the ſame time, that the colour might be rendered of any degree of deepneſs or lightneſs at pleaſure. If the Alcali is calcined with twice its weight of dried blood, and the Lixivium, obtained from it, poured into a ſolution of one part of Vitriol to ſix of Alum, the liquor acquires a very pale blue colour, and depoſites as pale a precipitate: On adding more and more of a freſh ſolution of Vitriol, the colour becomes deeper and deeper, almoſt to blackneſs. He imagines, with great probability, that the blue Pigment thus prepared will prove more durable in the air, mingle more perfectly with other colours, and be leſs apt to injure the luſtre of ſuch as are mixed with or applied in its neighbourhood, than that made in the common manner; the tarniſh and other inconveniencies, to which common Pruſſian blue is ſubject, ſeeming to proceed from the acid ſpirit, which cannot be totally ſeparated by any ablution——He takes notice alſo of an amuſing phœnomenon, which happens upon mixture. When the liquors are well ſtirred together, and the circular motion as ſoon as poſſible ſtopt; ſome drops of ſolution of Vitriol (depurated by long ſettling) let fall on different parts of the ſurface, divide, ſpread, form curious repreſentations of flowers, trees, ſhrubs, flying inſects, &c. in great regularity and perfection: Theſe continue ten or twelve minutes; and on ſtirring the liquor again, and dropping in ſome more of the ſolution of Vitriol, are ſucceeded by a new picture.

Mr. Macquer has ingeniouſly applied the preparation of this pigment to the dying of wool and ſilk; and found means of fixing the blue fecula in their pores. By dipping cloth firſt in a diluted ſolution of Vitriol and Alum, then in the ley diluted, and afterwards in water acidulated with Spirit of Vitriol, it acquires a light blue colour; which becomes deeper and deeper on repeating the dippings alternately in the ſame order as before; and adding to the liquors each time a little more of the reſpective ſaline matters. This blue dye, he ſays, in beauty and luſtre exceeds that of Indigo and Woad as far as ſcarlet does the Madder red; and penetrates the whole ſubſtance of fulled cloth, without weakening it. The colour is durable in the air, and ſtands boiling with Alum water, but is diſcharged by Sope, and, without certain precautions, liable to be ſpecky or unequal. See the Memoirs of the French academy for the year 1749.

(*o*) *Iron with Nitre.*] A part of the Iron is thus rendered ſoluble in water along with the alcalized Salt. A mixture of equal parts of Iron filings and Nitre, injected into a ſtrongly heated crucible, and after the detonation thrown into water, tinges the liquor of a violet or purpliſh blue colour. This ſolution however is not permanent: Though the liquor at firſt paſſes through a filter without any ſeparation of the Iron, yet on ſtanding for a few hours, the metal falls to the bottom in form of a brick-coloured powder. It is pretty ſingular, that volatile alcalies inſtantly precipitate the Iron from this fixed alcaline ſolution.

IRON. swells and grows hot, and if the quantity is large, bursts into flame: From this phœnomenon the chemists have endeavoured to account for earthquakes, subterraneous fires, and hot mineral springs.

Medical history of Iron. Iron is mechanically the most useful, and medicinally the most salutary, of all metals; possessing no deleterious power like most of the others, though its imprudent use may nevertheless be productive of dangerous consequences. Its primary operation is, to constringe and corroborate: And hence in cachexies and chloroses, in debilities and relaxations of the solids, it proves a medicine of great efficacy; whilst in the opposite circumstances it is as injurious as in these it is beneficial. Though it always acts immediately by an astringent quality, it often proves, in its consequential effects, aperient; promoting natural evacuations where the obstruction depends upon a laxity of the vessels; as well as restraining immoderate ones arising from the same cause— A great variety of preparations of it have been employed for medicinal use; as solutions in different acids, both mineral and vegetable, by themselves or in conjunction with vinous spirits, in their liquid state, or inspissated or crystallized; calces or croci made by fire alone, or by precipitation from acids, or by urging the inspissated or crystallized solutions with a strong fire till the acid has been expelled; and the rust made by exposing the filings to the air. The crude filings, are often as effectual as any of the preparations: If procured from the workmen in Iron, they should be carefully cleansed by winnowing and washing. For obtaining the rust most expeditiously, the filings should be spread thin, moistened, and set in a moderate warmth: Mr. Bourdelin observes, that the Iron increases in weight in this process, and that when thoroughly rusted, so as to imbibe no more water, it yields in distillation a volatile urinous spirit. Iron combined with acids, proves more astringent than by itself; but when the acid is separated, and the metal reduced to a calx, its activity is greatly diminished. The combination with vitriolic acid, or *Sal martis*, is directed to be made in the shops, by dissolving Iron filings in the acid, and crystallizing the solution: This however is a needless labour, the common green Vitriol, duly purified, being one and the same thing: If the Vitriol is suspected of containing any Copper, a little fresh Iron added to the solution of it, will effectually precipitate all remains of that metal: Even a pure Vitriol of Copper may be converted into a pure Vitriol of Iron, by dissolving it in water, and adding Iron to the solution; the Iron throwing down the Copper, and being dissolved in its place. The vitriolic and vegetable acids are the only ones with which Iron crystallizes or preserves a solid form: The marine renders it most effectually soluble in Spirit of Wine.

Natural History. Iron is exceeding rarely, if ever, found native in the earth. I have never yet seen a specimen of pure native Iron; the masses which have been shewn me as such, being either not attracted by the Magnet, or not dissoluble in Aqua fortis. Its ores on the other hand are extremely plentiful in almost all parts of Europe: But South America, so rich in Gold and Silver, has little of this most useful metal. The richest ores of Iron are compact and ponderous, of a browniſh, reddiſh brown or red colour:

lour (*p*): They ſcarcely ever participate of perfect Sulphur (the Pyritæ excepted) and contain but little foreign matter: Such are, the Magnet, the Hæmatites or Blood-ſtone, the common Iron-ſtone, and Ruddle. The running down of the Iron-ſtone requires no particular management, a ſtrong charcoal fire being the principal point: The ore is thrown in among the burning fuel, with the addition ſometimes of Quick-lime or Lime-ſtone (*q*).

Beſides

(*p*) *Iron ores.*] Some of the Iron ores, in colour and appearance, do not ill reſemble Iron itſelf; as the grey ore of Derbyſhire, and the bluiſh of the foreſt of Dean in Glouceſterſhire: Moſt of the Swediſh ores are likewiſe of this kind. Others are blackiſh, brown, red, yellowiſh, or ruſty coloured: Theſe are the moſt common ſorts in England and in Germany. There is one very ſingular ſpecies, of a ſtriated texture, a pale yellowiſh or greyiſh colour, oftentimes white, and in ſome degree pellucid: This, though in its crude ſtate it promiſes nothing metallic, on being moderately calcined, diſcovers, by the deep colour it aſſumes, that it abounds with Iron: Cramer informs us, that it gives out, on fuſion, from thirty to ſixty pounds of excellent Iron upon the hundred. Some of the richer ores yield no leſs than eighty on the hundred——Different kinds of Iron-ſtone are, in ſome mines, found adhering to the tops of caverns in form of icicles or ſtriæ, ſometimes irregularly cluſtered together, ſometimes hanging down like the briſtles of a bruſh: Whence the name Bruſh-iron-ore. Other particular ſorms of the Iron-ſtone have occaſioned a variety of fanciful names, to be met with in ſome of the metallurgic writers.

(*q*) *Smelting of Iron ores.*] The ores of Iron are commonly calcined previous to the fuſion; the harder ones, though they ſhould contain nothing ſulphureous or arſenical, requiring that proceſs to render them pulverable. In the large works, a quantity of the ore is placed on a bottom of wood or charcoal, intermingled with ſtrata of the ſame kind of fuel; the pile carried up to a conſiderable height, and ſet on fire.

The fuſion is performed in furnaces twenty or thirty feet high, and eight or ten feet wide in the middle, but narrower above and below. The furnace is charged at top with charcoal, and the fire excited by large bellows moved by water. When the whole internal ſurface appears of a ſtrong white heat, the ore is thrown in, by little at a time, with more charcoal over it, and commonly a portion of Limeſtone, the true uſe of which is probably, not as has been generally ſuppoſed, to abſorb Sulphur, but to promote the fuſion (ſee page 18.) The ore, gradually melting, drops down through the fuel into the receiver or bottom of the furnace, where a paſſage is open, for taking off the ſcum or droſs. The metal, now in ſtrong fuſion, is let out, by a tap-hole, into furrows made in a bed of ſand: The large maſs, which ſets in the main furrow, is called by the workmen a *ſow*, and the leſſer ones *pigs* of Iron. Chimney backs, ſtoves, garden-rollers, *&c.* are formed of this rough metal taken out of the receivers with ladles and caſt into moulds made of fine ſand. Two or three tuns of Iron are run off in twenty-four hours: Before the force of water was called in aid to work the bellows, ſcarce an hundred weight could be obtained in a day, and a large quantity of the metal was left in the droſs: Hence, in ſome places, the ſlags of the old works are now remelted to advantage along with freſh ore. From the richneſs of the ſlags of different ores left by former times, ſome have been miſled into an opinion, that the metal was regenerated in them.

From the great conſumption of wood in this buſineſs, and its ſcarcity in ſome places where there are rich mines of Iron, attempts have been made to ſubſtitute other fuels. Peat has been found to anſwer tolerably well: In ſome parts of England, a quantity of this has for a conſiderable time been mixed with the charcoal; and a patent has been lately obtained for running down the ore with peat alone. Pitcoal renders the Iron hard and brittle: This inconvenience is ſaid to be in good meaſure prevented, by previouſly coaking the coal, as is cuſtomary to fit it for the drying of malt.

IRON. Beſides the minerals which are commonly worked for Iron, there are many others in which ſmaller quantities are contained: From this metal the coloured clays and boles, and even the precious ſtones, receive their colour. Iron is truly an univerſal metal: Some portion of it has been diſcovered in all the mineral earths and ſtones that have been examined, in the ores of all other metals, and even in the aſhes of vegetables and animals. It was long diſputed betwixt two of the French academicians, Lemery and the elder Geoffroy, whether the Iron diſcovered by the magnet in vegetable aſhes, pre-exiſted in the plant, or was produced in the burning: Mr. Geoffroy's opinion is evidently the true one, namely, that the ferrugineous earth or calx exiſts in the vegetable, and is reduced into perfect Iron by ſome of the inflammable matter of the ſubject combined with it in the fire. The mineral earths and ſtones impregnated with Iron, and even its richeſt ores, contain no other than this calx of Iron; and no art can extract from them a grain of metal, without the introduction of inflammable matter.

Contained in coloured earths and ſtones, in animals and vegetables.

Differences in its quality. Iron proves greatly different in hardneſs, brittleneſs, malleability, *&c.* according to the quality of the ore it is obtained from (*r*), and the operation it has undergone. As firſt run from the ore, it contains an admixture of crude earth not perfectly reduced to a metallic form, and hence proves hard and brittle (*s*): By repeated forgings, this earth is forced out from its pores, and the

The impure Iron, as run from the ore, is melted down in another furnace, intermixt with charcoal; a ſtrong blaſt of air being impelled on the ſurface of the metal, by which its fuſion is remarkably promoted. On diſcontinuing the action of the bellows, the Iron thickens into a maſs called a *loop*, which is conveyed under a large hammer raiſed by the motion of a water-wheel. The Iron, beat into a thick ſquare, is heated till ready to melt, and forged again: By a few repetitions of this proceſs, it becomes completely malleable, and is at length formed into bars for ſale. A large quantity of vitreous ſcoria ſeparates both in the fuſion and the forging: The rough caſt Iron, obtained from ſome ores, loſes more than half its weight in being made into bars.

(*r*) *Differences according to the quality of the ore.*] There are very remarkable differences in the Iron obtained from different ores: From what particular admixtures or other cauſes they proceed, has hitherto been too little examined. The Iron run from ſome of the German ores, when forged only to a certain point, is found to be a good Steel; whilſt that of many others, taken in the ſame intermediate ſtate betwixt caſt and completely forged Iron, cannot be worked either as Steel or Iron. The Swediſh, and ſome of our own ores, yield an excellent tough Iron; whilſt others give a brittle metal that cannot by any forging be made perfectly malleable, and hence employed only for ſome kinds of nails and heavy works. The inferior ores are ſaid to be meliorated by mixing two or three different ſorts together.

(*s*) *Caſt Iron.*] Pure caſt Iron is for the moſt part ſo hard, as not to yield in the leaſt to the file or the chiſel; and extremely brittle, both whilſt cold and when ignited: Caſt into thin plates, it cracks, on being haſtily cooled, like glaſs. Broke, it appears of a dull white colour, approaching to that of unpoliſhed Silver; and of a ſmooth and uniform texture, compoſed of plates laid ſo cloſe together as ſcarce to be diſtinguiſhable even by a microſcope—The more impure ſorts are leſs hard to the file, but not leſs brittle under the hammer: Their colour is much darker, ſometimes a duſky grey, ſometimes almoſt black; their texture often granulated. On melting them, a quantity of glaſſy ſcoria ariſes to the ſurface; which, taken off, leaves the metal pure and white like the foregoing ſort.

Pure

the metal becomes ſofter and more malleable (*t*). The workmen commonly judge of the goodneſs of caſt Iron, from its bearing a ſtrong fire, when made into veſſels, without bliſtering; and of that of forged Iron, from its being malleable

Pure caſt Iron, ſurrounded with animal aſhes, and expoſed to a fire not ſufficient to melt it, becomes in a ſhorter or longer time, according to the ſtrength of the fire and the thickneſs of the metal, ſo ſoft, that ornaments or utenſils made of it, however hard before, may now be eaſily cut, filed, embelliſhed, or freed from their ſuperfluities. The gradual changes, produced in this proceſs are pretty remarkable.

Iron, ſuffered to cool in the mould, appears on the ſurface of a ſlate blue colour; a ſure mark of its being hard. After the cementation has been continued for a certain time, it looks externally of a dark coffee or blackiſh colour, internally far leſs white than before, and no longer of a ſmooth, but of a rough granulated ſtructure. In this ſtate, it yields to the file if ſlowly cooled; but if cooled haſtily by quenching in water, or if heated a ſecond time and then quenched, it is not touched by the tool: Hence works of caſt Iron, ſoftened to this degree, may be filed or cut, and afterwards readily hardened again. It does not bear the hammer when cold, but proves in ſome meaſure malleable when ignited: When ſtrongly heated, I have generally found it crack or fly in pieces from a moderate blow.

On further continuing the cementation, the dark colour which the metal had before acquired, gradually goes off, and at length changes into a white, with a conſiderable degree of brightneſs, which the Iron had nothing of at firſt: The texture likewiſe alters, but not equally in all kinds of Iron, ſome proving granulated and others plated. The metal is now fully ſoftened: It may be eaſily cut with a chiſel, bent without breaking, and extended under the hammer: Nor does it acquire any conſiderable hardneſs on being heated and quenched in cold liquors.

In proportion as the Iron becomes ſoft, it loſes of its fuſibility. If the cementation is continued only till the outſide is ſoftened; on raiſing the fire, all the inner hard core will melt and run out, leaving the outer ſoft part entire and of its original form. If any part of the ſurface is covered with ſand, or left uncovered with the ſoftening matter, the melted core will run out there.

Sand or powdered Flint ſomewhat retard the ſoftening. Argillaceous and gypſeous earths, particularly the latter, occaſion the Iron to ſcale greatly. The mineral calcareous earths have nearly the ſame effect as animal aſhes, but with leſs certainty: After the Iron has been ſoftened by them in a moderate fire, it ſometimes, in a ſtronger, reſumes its original hardneſs: They are likewiſe apt to make the ſurface ſcale, and thus obliterate the finer impreſſions received from the mould. Bone-aſh itſelf is ſubject alſo to this laſt inconvenience, where the largeneſs of the maſs of metal requires the fire to be long continued: The admixture of a little powdered charcoal prevents the ſcaling, without ſeeming to affect the ſoftneſs or hardneſs.

The foregoing obſervations are drawn chiefly from the experiments of M. de Reaumur referred to by our author. I have added not a few of my own; but without being able to add much to the conſequences deducible from his; or to diſcover the principle on which the change is effected; or to ſoften the pureſt and fineſt caſt Iron near ſo effectually by cementation as by forging.

(*t*) *Forged Iron.*] When caſt Iron is heated till ready to melt, and compreſſed by repeated blows of large hammers; a quantity of vitreous matter is forced out and thrown off; its parts are more regularly arranged; the plates rendered ſmaller and more diſtinct, by degrees changed into grains, and at length into fibres. Fine plates regularly arranged, ſmall grains, or fibres like thoſe which appear upon the fracture of wood, are marks of tough Iron, provided it is not ſulphurated: Large and irregular plated Irons are univerſally ſhort or brittle. The colour of the fracture is uſually whitiſh and conſiderably bright; though ſome, even of the better ſorts of Iron, look dull, without any brightneſs.

Pure well forged Iron is malleable both when

IRON. malleable both when hot and cold, making good Steel, and lasting well when employed for such uses as require it to be kept wet, as in pegs for the axletrees of mill-wheels, &c.

Steel. Forged Iron is converted into Steel, by cementation, in close vessels, with inflammable and saline substances, as the horns and hoofs of animals, or mixtures of Sea-salt, soot, and wood ashes. Steel is much harder, more brittle, and more elastic than the Iron was at first; and all these qualities are in good measure at the command of the artist. Heated a little, and quenched in water, it proves extremely hard: By an increase of the heat, it becomes softer and softer; and by a continuance or repetitions of it, returns into Iron again; losing by degrees the inflammable or other principles, the introduction of which had made it Steel (*u*). The hard cast Iron, as well as Steel, is rendered soft, by

when cold and hot, though not with equal facility: The further it is heated, it extends the more easily, and is the less liable to crack——Some sorts of Iron, though malleable when cold, prove entirely brittle if heated red; others are brittle when cold, and malleable only whilst ignited: The former are called by the workmen *red-share*, the latter *cold-share* Irons. The imperfection of the first is supposed to be owing to an admixture of Sulphur: That of the second proceeds wholly from a want of sufficient forging——Forged Iron is a little heavier than the cast; in the proportion of about $7\frac{8}{10}$ to $7\frac{1}{10}$. It scorifies much more in the fire, and does not melt without additions or the immediate contact of the fuel.

The author above-mentioned observes, that the substances which soften cast Iron by cementation, increase the softness of the forged to a certain point: That if the operation is continued beyond this period, they render it harder and more brittle than at first; that gypsum remarkably promoted the fusion of the metal; bars of Iron, surrounded with gypsum, having scaled in a moderate heat, and in no very strong one melted. It is commonly supposed, that Iron, by whatever means it is brought into fusion, totally loses its malleability: But I have found, that when thus melted with gypsum, it remains malleable in a great degree; and that it will now melt a second time, without any addition, and still retain its malleability. The Iron, surrounded with the gypsum, did not perfectly melt till the fire had been raised so high, that the gypsum begun to dissolve the Hessian crucibles, which were sometimes corroded internally to the thinness of paper, and sometimes perforated.

Forged Iron, cemented in close vessels with vegetable or animal coals, gains a sensible increase both in bulk and weight, and now commences Steel——From the remarkable changes produced in Iron by earthy and inflammable matters, I was led to submit Copper and some other metals to the same treatments, but could not observe that they suffered any change.

(*u*) *Steel.*] Steel is found to differ in quality according to the particular ingredients with which the cementation is performed, as well as the goodness of the Iron it is made from. M. de Reaumur observes, that inflammable substances alone, as soot, charcoal, animal matters, render the Steel hard to work and apt to crack; that the admixture of absorbent earths, as wood ashes, prevents this inconvenience; that a little Sea-salt, added to these, contributes to the fineness and durability of the Steel, and at the same time expedites the change; whilst some other saline substances, as Sal ammoniac, Sandiver, Vitriol, alcalized Nitre, rendered it far less durable. The cementation has been usually performed in earthen coffins or chests, fitted with covers, of sufficient capacity to receive a great number of bars at once. There is a large Steel-work in Yorkshire, where the furnace itself is divided into partitions or chambers for receiving the Iron with the cementing mixture, with spaces between for the passage of the fire: The fire is raised by degrees for a week, and then suffered to decay of itself. The increase which the Iron gains in this

process

proceſs is ſaid to be ſo conſiderable, as to bear the charges of the fuel——The caſe-hardening of Iron, by cementing it for a little time with burnt horns, leather, and other like ſubſtances, is no other than a ſuperficial converſion of it into Steel.

Steel, ſuffered to cool leiſurely in the furnace, yields to the file; breaks, whilſt cold, from a moderate blow; and diſcovers a laminated texture and dull colour, though the Iron was fibrous and bright before. Conſiderably heated, it may be hammered or welded; and if ſuddenly cooled, by quenching in cold liquors, proves much harder than at firſt, of a bright whitiſh ſurface, and no longer of a plated, but of a granulated ſtructure: The grains are larger or ſmaller according as the Steel is more or leſs hard. Both the texture and colour are always different from thoſe of the Iron which it was made from; though ſome kinds of Iron are in theſe reſpects little different from ſome kinds of Steel.

A bar of white poliſhed Steel, laid upon burning charcoal, ſo as to heat ſlowly, becomes at firſt paler; then of a dilute yellow, which deepens by degrees into a gold colour: As the heat increaſes, the gold colour changes to a purple; this is ſucceeded by a violet, and the violet by a deep blue, which weakens inſenſibly to a water colour, the laſt ſhade that can be diſtinguiſhed before the bar grows red-hot. All theſe colours may be exhibited on the ſame bar at once, by applying the heat only at one end; and fixed or detained upon it, by quenching it in cold water as ſoon as they appear.

Theſe different colours are accompanied with manifeſt differences in the texture, hardneſs and tenacity of the Steel, and prove ſure guides to the workman for giving his ſprings and tools the temper proper for each. Steel in its white ſtate is exceſſively hard, not to be filed, ſcratched or cut, and incapable of receiving any impreſſion or alteration of form without extreme violence: Hence it is fit for making dyes to ſtamp coins and medals, for forming the ſurface of anvils, hammers, &c. When yellow, it proves more tractable, yet ſufficiently hard to make files, drills and other tools capable of cutting ſuch as is of a violet or blue colour. In this laſt ſtate, it is ſomewhat ſoft, ſo as to be punched, filed, drilled, toothed, made into ſaws; and highly elaſtic, fit for ſprings, which may be coiled or uncoiled without breaking or injury.

If Steel be cemented afreſh with the Steel-making mixture, or if the proceſs at firſt be long continued; the metal proves exceſſively brittle, incapable of being welded, apt to crack and fly in pieces in forging, and on raiſing the fire, melts, like caſt Iron. Cementation with abſorbent earths, or fire alone, change it from this ſtate firſt into tractable Steel again, and afterwards into malleable Iron, ſomewhat finer and purer than the Iron was at firſt.

Mr. Reaumur ſuppoſes that common caſt Iron itſelf is no other than an impure ſpecies of melted Steel; and that on ſoftening it, whether by cementation or by forging, it becomes perfect Steel before it becomes malleable Iron. The German Steels are made directly from caſt Iron, by forging it only to a certain point. This kind of Steel is leſs certain in quality than that made from forged Iron, and has generally veins of ſoft Iron: An account of the manner of preparing it was publiſhed ſome years ago in a treatiſe *Sur l'acier d'Alſace*.

The ancients have been ſuppoſed, from the hardneſs of ſome of the ſtatues which they have left us, and from the Egyptian obeliſks, which though carved with a variety of figures, reſiſt the tools of later ages; to have had peculiar methods of making Steel of a degree of hardneſs ſufficient to cut thoſe refractory ſtones. Dr. Liſter complains, that this valuable ſecret is now loſt; and that the proceſſes, uſed by moſt nations, are a poiſoning of Iron by mineral Salts, rather than a true making of Steel——So far as can be judged from the imperfect accounts given by Ariſtotle and Pliny, the ancient Steel was made by keeping forged Iron for a certain time in melted caſt Iron. Agricola deſcribes a proceſs on the ſame principle, which Kircher aſſures us was practiſed in the iſland Ilva from the time of the Romans to his own. And this is the method which Liſter propoſes, for retrieving the loſt ſecret——The proceſs is curious, and affords, by proper management, a perfect Steel, but not ſuperior in hardneſs to the common ſort. It is probable, that the ſecret of the ancients did not conſiſt ſo much in giving their tools an extraordinary hardneſs, as in employing the ſtones in a ſofter ſtate than that in which we now find them.

There

IRON. by cementation with earthy matters, as bone aſhes, mixed with a little powdered charcoal. See Reaumur's treatiſe on the converſion of forged Iron into Steel, and the ſoftening of caſt Iron.

EMERY. Some of the ores of Iron are more valuable for other uſes, than for being worked as Iron ores. Such are, (*x*)

Different ſorts. I. EMERY: *Smiris*, *ſmerillus*, *ſmyrites*, ſo called from σμαω or σμεω, to cleanſe or poliſh. Three ſorts of this ſtone are mentioned by authors; a golden, cupreous, and ferrugineous Emery. The golden Emery is ſaid to be found

There are ſundry ſtones which have their hardneſs improved by long expoſure to the air: There are others which in their natural ſtate are ſo ſoft as to be eaſily cut with a knife and turned in a lathe, but gain from fire a degree of hardneſs which is proof againſt the chiſel. See page 26.

(*x*) *Ores valuable for other purpoſes.*] Such alſo is the *lapis hæmatites* or blood-ſtone, the *glaſs-kopf* of the German writers. This is an elegant Iron ore, generally of a reddiſh colour, very ponderous, and of great hardneſs, inſomuch as to be uſed, like Emery for poliſhing Glaſs and Steel. Its figure is ſomewhat pyramidal: One ſide is convex, the other angular. Broke longitudinally, it exhibits ſtriæ converging to the ſmaller end: Its tranſverſe fracture reſembles that of ſoft Steel. Expoſed to a moderate fire it falls into ſcales, and in this ſtate adheres readily to the magnet, and gives out its Iron to acids; neither of which had any action on it before. In a vehement fire, it yields a white brittle Regulus of Iron, which is very difficultly rendered malleable. Nevertheleſs, in ſome parts of Germany, where it is plentiful, it is ſaid to be worked for Iron to advantage.

The native red and yellow ochres, employed as pigments by the painters, are no other than ores of Iron, compoſed of a calx of the metal blended with an argillaceous earth: The ponderous deep red ochre called ſmit, and the reddle or red chalk, are rich in Iron. Swedenborg informs us, that in ſome provinces of Sweden, different ochres, frequent in marſhy places and at the bottoms of ponds, are dug in ſummer when the waters have dried up, and ſmelted for Iron; that ſome yield upwards of one fifth their own weight, though there are others which ſcarce afford one twentieth.

Manganeſe or Perigord ſtone, *Magneſia*, *lapis petracorius*, the *braunſtein* of the Germans, has hitherto been ranked among the ores of Iron. This mineral is uſually of a dark grey colour; ſometimes bright and ſtriated like Antimony; ſometimes dull, with only a few ſmall ſtriæ. It is found chiefly in mines of Iron; though conſiderable quantities are likewiſe met with in the Lead mines of Mendip hills.

Manganeſe, ſtrongly calcined, becomes brown. Small proportions of the calx, melted with Borax, with compoſitions of Flint and Alcali, or with common Glaſs, comunicate different ſhades of purpliſh or red colours. On continuing the Glaſs in ſtrong fuſion, the colour which it had received from the Manganeſe diſappears, and the effect of ſundry other colouring matters alſo is at the ſame time deſtroyed: Hence the uſe of Manganeſe in making colourleſs pellucid glaſſes, for conſuming any accidental tinge. Larger proportions give a brown or black colour: Hence its uſe in the compoſition of black enamels, and in the black glazings for earthen ware. The bright ſtriated ſort is generally preferred by the glaſs-makers, and the other by the potters.

Mr. Pott has given ſome experiments on this mineral (*Miſcellan. Berolinenſ. tom.* vi.) from which it does not appear to contain any Iron. He obſerves that it is not attracted by the magnet either in its crude ſtate, or after it has been expoſed to the fire in conjunction with inflammable ſubſtances; and that it yielded nothing metallic on being urged by a ſtrong fire with the common reducing flux——With twice its weight of Nitre, it did not deflagrate; the mixture boiled up, ſoon after concreted into a blackiſh grey maſs variegated with yellow ſpots, leaving on ſome parts of the crucible a green or purpliſh glazing. The powdered

maſs

found in the Peruvian and other American mines, to be of a reddiſh colour, to have ſmall veins or ſpecks of Gold and Silver imbedded in it, to be very rare, and its exportation to be prohibited by the King of Spain: The cupreous ſort, to be likewiſe reddiſh, but more equal and free from veins, to hold no Gold or Silver, and to be found in Copper mines in Europe: The ferrugineous, to be of a ſparkling whitiſh, a dark grey, or a blackiſh colour, to be found in rich Iron mines, and to be the leaſt valuable ſort. EMERY.

The common Emery, whatever be its colour, whether reddiſh, greyiſh or blackiſh, is a compact ſtone, ſo hard as to cut Glaſs like the diamond; impregnated with Iron, and a very ſmall portion of Copper. It is met with in Norway, Sweden, England, Saxony, and other countries: Bruckman relates that the Emery found at St. Georgenſtadt in Miſnia is ſuperior to the Spaniſh. It is uſed for cutting and poliſhing precious ſtones, for poliſhing Agate, Porphyry, Marble, Glaſs, metalline Specula, Iron and Steel, and the various utenſils and ornaments made of theſe kinds of ſubſtances. For theſe purpoſes, the Emery is ground in mills, the powder paſſed through ſieves of different degrees of fineneſs, and thus divided into different ſortments, the fineſt of which are, for the nicer uſes, further divided by waſhing them over ſeveral times with water. The refuſe Emery, in grinding, or ſuch as has been uſed in poliſhing, is, in France, dried and kept apart under the name of *potée d'Emery*. Some have employed powdered Emery, from its power of poliſhing hard ſtones, as a dentifrice: But for this uſe it is by no means proper, as it wears off the natural poliſh of the teeth.——It has been ſaid that Emery gives out ſome red matter on the whetſtone: Where this has been obſerved, the Emery employed muſt have been the red kind, or a ſpecies of hæmatites; for the others yield only a grey colour on the ſtone. Common: Its uſes:

I have tried to ſmelt this mineral with the ſeveral fluxes uſed in aſſays for Iron, as alcaline Salt, Borax, Charcoal duſt, Pitch, Tallow, *&c.* but could not procure a fire ſufficiently ſtrong to fully maſter the refractory ſtony matter: Though there was not, however, any perfect Regulus of Iron obtained, there Examined by fire,

maſs did not deliquiate in the air: On the affuſion of warm water, it acquired an elegant green colour, which was ſoon ſucceeded by a blue and a purple, and then returned into green again: On ſhaking the Glaſs, the ſame beautiful ſucceſſions of colour repeatedly appear. The green ſolution, paſſed through a filter, and digeſted or boiled, loſes its colour, depoſiting a fine yellow powder, which calcines brown, diſſolves in acids, and is not precipitated by alcaline Salts——The ſame phœnomena were obſerved on treating the Manganeſe with fixed alcalies inſtead of Nitre——Acids have no effect upon crude Manganeſe, but partially diſſolve it when calcined: The ſolutions are colourleſs, except that made with Spirit of Vitriol, which has a ſlight roſe colour; On adding alcalies, a white earth is precipitated——Sal ammoniac elevates nothing from it in ſublimation, but parts with a little of its own urinous ſpirit: The reſiduum, which appears of a reddiſh colour, partly diſſolves in water, leaving a whitiſh earth: The ſolution coagulates with alcaline Lixivia——Calcined with Sulphur, it forms a yellowiſh brown maſs, which yields, with water, a large quantity of a white cryſtalline Salt, of a bitteriſh aſtringent taſte followed by a kind of ſweetneſs. This Salt yields in diſtillation a ſulphureous phlegm, and a little ammoniacal Sublimate, but no acid ſpirit: The reſiduum taſtes like burnt Alum, but more acid. A ſolution of the Salt effervesces with alcalies, and depoſites a white earth: It does not change colour with Galls.

EMERY. there were abundance of particles which the Magnet attracted. Emery in its crude ſtate is not affected by the Magnet. All acids extract ſomewhat from the Emery, but none of them diſſolve one half of it. In each of the following experiments was employed half an ounce of the menſtruum, and ſixty grains of the powdered ſtone. Spirit of Nitre diſſolved only thirteen grains out of the ſixty; the ſolution looked ſlightly yellowiſh, the reſiduum of a pale brown. Spirit of Salt took up ſeventeen grains, and acquired a gold-yellow tincture, leaving the powder of a pale brown. Aqua regia diſſolved twenty grains, and acquired a like yellow colour, leaving a yellowiſh brown powder. Spirit of Vitriol diſſolved twenty-four grains; the liquor continued colourleſs, the reſiduum greyiſh brown. Oil of Vitriol ſeemed to act upon the powder, to corrode and render it white; but no true ſolution enſued. Fixed alcaline Lixivia had no effect; but volatile ſpirits extracted a blue tincture, and took up about half a grain out of the ſixty grains of Emery: The remaining powder looked reddiſh brown. Infuſions of Galls, mixed with Oil of Vitriol that had been digeſted on Emery, depoſited a white Precipitate; with the ſolution or extraction made with Spirit of Vitriol, a grey Precipitate; with the tincture in Spirit of Nitre, a brown one; with that in Aqua regis, a blackiſh brown; with the tincture made in Spirit of Salt, the liquor ſeemed at firſt to become inky, but on ſtanding, the colouring matter precipitated.

by acids, &c.

Sophiſtication of Gold with Smiris.

The alchymiſts have expected extraordinary effects from this mineral, and pretended by its means to fix Mercury, to augment Gold, *&c.* They have mixed with Gold an *extractum ſmiridis*, and thus increaſed indeed the quantity, but proportionably debaſed the quality of the Gold; for the matter ſo introduced is by no means true Gold, and does not ſtand the teſts of that metal: An experienced artiſt obſerves, that on amalgamation with Mercury, the adventitious matter is ſeparated and thrown out, almoſt as Calamine is from Braſs by a like treatment, and thus diſcovers that it is of a different nature from Gold. There is no real Gold to be obtained from the European Emeries; that ſome ſhould be got from the Peruvian, is little wonder, native Gold being imbedded in that, as in the other ſtones in the Gold mines.

MAGNET. II. The LOADSTONE or MAGNET: *Magnes, lapis Heracleus, lapis Herculeus, lapis Lydius, lapis Nauticus, Siderites.* This ſtone is externally of a blackiſh, a brown, or a browniſh grey colour; ſometimes compact, and moderately hard; ſometimes ſoft, porous, and brittle. The beſt I have ſeen were of a blackiſh hue, or at leaſt more of a brown than a grey, much reſembling old Iron. It is found in all the four quarters of the world, though not in each of the provinces into which they are ſubdivided; in the Eaſt-Indies, Ethiopia, Macedonia, Bœotia, *&c.* in Spain, France, Norway, Ruſſia, Scotland, England, Sweden, Italy, Pruſſia, Hungary, Bohemia, Lithuania, Germany; more particularly in Saxony and Sweden; ſometimes in diſtinct mines, but moſt frequently along with the more common ores of Iron. In Saxony, the beſt Magnets are met with at Ehrenfriederſdorf, Schwartzenberg, and Breitenbrunn. Theſe ſtones were formerly divided according to the different countries they were brought from: But this circumſtance is now diſregarded, the value depending wholly upon their qualities.

The

The distinguishing characters of the Loadstone are, that it attracts Iron; and that when placed so as to move round with very little friction, as when suspended by a thread, or laid on a piece of cork floating in water, a certain point or pole turns always northwards, and another opposite one southwards. The first of these properties renders it useful to the chymist for discovering or separating small particles of Iron mixed with other matters: By the second, it proves an invaluable guide to the seaman. MAGNET. Its distinguishing characters.

The Magnet attracts no other substance but Iron; and Iron only in its perfect metallic state: It does not touch the calces or croci, or sulphurated Iron, and acts but on few of the ores, till art has freed them from their Sulphur, or impregnated them with inflammable matter (*y*). Henckel observes, that it attracts Iron when mixed with considerable proportions of sundry other metals; of Gold, Silver, Copper, Brass, Tin, Zinc, Bismuth, and Arsenic; but discovers no action upon Iron that has any admixture of Regulus of Antimony. If Iron be mixed only superficially, in filings, with any other metallic body, a cautious application of the Magnet will extract the Iron; though a vigorous Magnet, hastily applied, will take up the filings of the other metal intermixed among those of the Iron. If a Magnet be rolled in Iron filings, a few of the filings will adhere all over its surface; but they will be plentifully accumulated on two particular points of the stone, and these points are its poles. It attracts Iron without actual contact, and in different media; in vacuo, in air, in water, with the interposition of various solid bodies, wood, glass, stones, metals, *&c.* The degree of attractive power differs in different Magnets: In the history of the French Academy for the year 1702, there is an account of a Loadstone in Holland, which weighed but ten ounces, and lifted eighteen pounds, that is, above forty times its own weight: Tergazzi mentions a Magnet which lifted sixty; and Boyle, one which lifted eighty times its weight. This last is probably the stone taken notice of by father Bonanni (in the *Musæum Kircherianum*, p. 203.) which weighed no more than two ounces, and sustained ten pounds. I have myself seen some which bore four, six, eight, ten, twenty times their own weight: The largest I ever saw was one found in Devonshire and kept in the Museum of the Royal Society in London: This weighs sixty pounds, but does not lift much, though it moves a compass needle at the distance of nine feet. The power is greatly increased by arming, as it is called, or uniting the virtues of both poles by means of flat pieces of Iron of a proper thickness. Lani relates, that he had a Magnet which, unarmed, lifted only fifty-four grains; but when armed, eight hundred and four. Schottus mentions a Magnet in the possession of the grand Duke of Florence, Attractive power.

(*y*) *Action of the Magnet on Iron ores.*] It is observable, that several of the hard ores of Iron, which are not affected in the least by the Magnet in their natural state, are vigorously attracted by it when moderately roasted, though, without the contact of any inflammable, and without seeming to lose any sulphureous, matter: And that the calces of Iron, by slight roasting with inflammable additions, are made to obey the Loadstone, and revived into their metallic form, each particle appearing now to be perfect Iron; whilst the calces of other metals are in no degree revived without being brought into fusion. It is probably this *revival* of the calx of Iron that Macquer means, when he says it *melts* sooner than Iron itself; for it does not melt at all in any degree of fire that can be excited in the furnace of the chemist.

MAGNET. Florence, which weighed twenty-nine pounds, and lifted ſixty-five: Manfredus Settala had one, which weighed but a pound, and lifted ſixty pounds. It may be obſerved, that the Iron, appended to the armature, adheres only by two points or lines, and will be retained rather more firmly when the ſurface is rounded, than when it is flat. If a circular plate of Iron be made to ſpin upon a table, and in that ſtate taken up by a Magnet, it continues ſpinning for a time as it hangs from the ſtone.

Communicative and repulſive power. The Magnet communicates to Iron drawn over one of its poles, both its attractive and directive power, without loſing any virtue itſelf: Hence compaſs needles, and magnetic Steel bars: The harder the metal, the more difficultly it receives, and the longer it retains, the magnetic power. Each of theſe has two poles, like the natural Magnets: Either pole attracts common Iron or Steel: But the North-pole of one Magnet repels the North-pole of another, whether natural or artificial; and the South-pole repels the South: Oppoſite poles attract each other: Iron rendered magnetic by one pole of a Magnet, has its virtue deſtroyed by touching it on the other. Iron is capable of being rendered magnetic, and ſtrongly ſo, without the aſſiſtance of any natural Loadſtone: See ſome curious papers on this ſubject in the Philoſophical Tranſactions.

Directive power. The direction of the Magnet or magnetic needle is not always in the plane of the true meridian; but declines towards the Eaſt or Weſt, more or leſs in different places, and in one place at different times. One end of a needle, when made magnetic, inclines below the horizontal plane: In northern latitudes it is the North, and in ſouthern ones the South-pole which dips.

Its power weakened and deſtroyed. The virtue of Magnets is weakened, by moiſture of every kind; by unctuous or oily ſubſtances; by all Salts, whether in a ſolid form or diſſolved; by being long kept in the neighbourhood of another Magnet, or without any charge of Iron; by the Iron in contact with the ſtone becoming ruſty. A Magnet reduced into powder, immediately loſes all its virtue; as ſome fragrant flowers loſe all their ſmell on being bruiſed: The powdered Loadſtone, far from being able to attract Iron, is ſcarcely itſelf attracted by a vigorous Magnet. How ridiculous then the practice, by ſome recommended, of mixing powdered Loadſtone in plaſters, for extracting Iron out of the fleſh!

Muſſchenbroek relates that the power of the Magnet is not deſtroyed by fire; that on the contrary, a Magnet which has loſt its power by being pulveriſed, recovers it again, ſo as to adhere to a freſh Magnet, by reverberation in a ſtrong fire. That author appears, throughout his treatiſe on this ſubject, an able philoſopher and mathematician, but no chymiſt: The powdered Loadſtone is a ferrugineous ore, and is no more attracted than the common ores of Iron in their natural ſtate: By calcination, in contact with flame or inflammable matter, the Iron is revived into its metallic form, and the powder adheres to a Magnet, not as being itſelf a Magnet, but as being Iron.

Examined by fire and menſtrua. The Magnet calcines to a reddiſh brown colour; and melted with inflammable fluxes, yields a conſiderable portion of true Iron. Sal ammoniac ſublimed from it, elevates ſo much of the Iron as to acquire a yellow colour, in the ſame manner as when ſublimed from Iron filings. Spirit of Nitre totally diſſolved it into a yellow liquor, which on ſtanding depoſited a ſmall quantity of yellowiſh Precipitate, amounting to about a grain and a half from thirty

grains of the ſtone. Spirit of Salt diſſolved only twenty-five grains out of thirty: Both the ſolution, and the undiſſolved powder appeared yellow. Spirit of Vitriol diſſolved fourteen grains out of thirty; and Oil of Vitriol corroded twenty grains into a white calx. No vitriolic cryſtals were obtained by evaporating the ſolution made in the vitriolic acid. MAGNET.

IV. TIN.

TIN, *Jupiter*, is a white Silver-coloured metal, not at all ſonorous or elaſtic, a little harder than Lead, ſofter than any of the other metals, very ductile, ſo as to be beat into thin leaves (z). It is the lighteſt of all the malleable metals; being little more than ſeven times heavier than an equal bulk of water. TIN. Fuſibility.

It melts in the fire before it grows red-hot; and on continuing the fire, and frequently ſtirring the fluid metal, ſlowly calcines into a white powder (*a*). Though Tin itſelf is ſo eaſy of fuſion, its calx is extremely refractory (*b*); not flying off in the fire, as Boerhaave pretends; but ſtanding the greateſt heat procurable in our furnaces, without melting or ſuffering any attraction: Even when mixed with fuſible vitreous matters, it does not perfectly melt with them, but renders a large proportion of the Glaſs opake and milky: Nor is it eaſily reducible into Tin again.

Though Tin, of itſelf, is ſo ſoft and ſo unſonorous; it ſurprizingly improves the ſonorouſneſs, and deſtroys the ductility, of ſome of the other metals, particularly Gold, Silver, Copper, and Braſs. Bell-metal, the moſt ſonorous Effects on other metals.

(z) *Tin—ductile.*] Tin is commonly reckoned the leaſt ductile of all the malleable metals except Lead: In regard to ductility into wire, it certainly is ſo; but in regard to extenſibility into leaves, it is not. Theſe two properties ſeem to be leſs connected with one another than is generally imagined: Iron and Steel are drawn into exquiſitely fine wire, but cannot be beat into leaves: Tin, on the other hand, is beat into fine leaf, and cannot be drawn into wire. Gold and Silver poſſeſs both properties, the moſt eminently of all metallic bodies: Whilſt Lead, notwithſtanding its flexibility and ſoftneſs, cannot be made either into leaves or wire of any fineneſs.

(*a*) *In the fire.*] It melts the moſt eaſily of all the metals; about the four hundred and thirtieth degree of Fahrenheit's thermometer——Heated till almoſt ready to melt, it proves extremely brittle: Large blocks, are in this ſtate, eaſily beat in pieces from a blow: The purer ſort, from the facility of its breaking into long ſhining pieces, is called *grain Tin*. Melted, and nimbly agitated at the inſtant of its beginning to congeal, it is reduced into ſmall grains or powder.

In calcination, it contracts on the ſurface a browniſh grey powdery pellicle; which, on raiſing the fire to a cherry red, ſwells and burſts, and diſcharges a ſmall bright white flame of an arſenical ſmell. The metal, when juſt calcined, appears of a duſky greyiſh or aſh colour: By a longer continuance of the fire, it becomes white, the more ſo in proportion as the Tin was the more pure.

(*b*) *Calx unfuſible.*] It is the moſt refractory of all metallic calces, that of Platina excepted. Even in the focus of large burning-glaſſes and mirrors, it only ſoftens a little and forms cryſtalline filaments. With glaſs of Biſmuth, and the ſimple and arſenicated glaſſes of Lead, the moſt powerful fluxes known for refractory calces, it does not perfectly vitrify, forming only opake milky compounds. By this property it is fitted for making the baſis of the imperfect glaſſes called enamels.

TIN. norous of all metallic bodies, is a compoſition of Copper and Tin. The minuteſt portion, even the vapour of Tin, renders many ounces and even pounds of Gold or Silver, ſo brittle as to fall in pieces under the hammer. The leaſt particle of Tin, falling on the ſtones, or luting of a furnace, will make all the Gold and Silver melted in it, hard and brittle: From ſuch an accident, the Gold and Silver-ſmiths are obliged to pull down the whole furnace, and build a new one with freſh materials.

Differences from Lead. Tin has been ſuppoſed by ſome to be nearly allied to Lead; as approaching to it in colour, ſoftneſs, fuſibility, and calcinability. The differences however are much greater than the reſemblances; Lead being far heavier than Tin; running eaſily into a tranſparent Glaſs, whilſt Tin does not vitrify at all; not producing, in the malleable metals that remarkable brittleneſs, which has procured Tin the title of *diabolus metallorum*.

Tin and Iron expoſed to a burning-glaſs. Tin, the moſt fuſible, and Iron the moſt refractory, of the metals, unite eaſily with one another, and ſeem to have a great affinity (*c*). On mixing them in the focus of Tſchirnhaus's burning-glaſs, I obſerved, that when the Tin was melted firſt, and the Iron added, they united together very quietly; but that when the Iron was melted firſt, the addition of Tin occaſioned a crackling, and a ſputtering of little globules, which burſt with a conſiderable ſnap: Inſtead of fumes, there aroſe exceeding fine filaments, which ſtuck to the clothes, *&c.* like cobwebs.

Tin deflagrates ſtrongly with Nitre, and alcaliſes the Salt. The filings, held in the flame of a candle, yield a ſmell reſembling that of Garlic, and thus appear to contain an arſenical matter (*d*): Hence the ill effects of Tin on thoſe who are much expoſed to its vapours.

Tin

(*c*) *Affinity of Tin and Iron.*] Iron is diſſolved by melted Tin, in a heat far leſs than that in which Iron by itſelf melts: The compound is white and brittle. Iron, added to a mixture of Tin and Lead in fuſion, takes up the Tin, leaving the Lead at the bottom: And in like manner, if Lead, Tin and Silver are melted together, the addition of Iron will abſorb all the Tin, and the Tin only. Hence we are furniſhed with a method of purifying Silver from Tin, and conſequently of preventing the inconveniencies which this metal conſtantly occaſions in the refining of Silver by cupellation with Lead.

(*d*) *Tin and Arſenic.*] Tin melted with Arſenic falls in great part into a whitiſh calx: The part which remains uncalcined proves very brittle, and appears of a white colour and a ſparkling plated texture, greatly reſembling Zinc. The Arſenic is very ſtrongly retained by the Tin, ſo as ſcarce to be totally diſſipable by any degree of fire: Though the mixture be urged for a length of time, with a very intenſe fire; the Tin, afterwards recovered by fuſion with inflammable fluxes, diſcovers, by its appearance, by its brittleneſs, and by its augmentation of weight, that it ſtill holds a conſiderable portion of the Arſenic. Hence, as the common Tin ores abound with Arſenic, the common Tin is found alſo upon experiment to participate of that mineral——Henckel diſcovered a method of ſeparating actual Arſenic from Tin; namely by ſlowly diſſolving the Tin in eight times its quantity of an Aqua regia made with Sal ammoniac, and ſetting the ſolution to evaporate in a gentle warmth: The Arſenic begins to concrete whilſt the liquor continues hot, and more plentifully on its growing cold, into white cryſtals. Mr. Marggraf, in the Berlin Memoirs for the year 1747, has given a more particular account of this proceſs: He obſerves that the white ſediment which at firſt ſeparates during the diſſolution, is chiefly arſenical: That Malacca Tin, which

is

TIN.

Tin diſſolves in all the mineral acids. For its diſſolution in the vitriolic, it requires the acid to be highly concentrated, and aſſiſted by a boiling heat: The inflammable principle of the Tin, extricated during the diſſolution, unites with a part of the acid into a true Sulphur; which ſublimes, in its proper form, into the neck of the retort. Solution in different acids.

The nitrous acid acts upon Tin much more eaſily: To obtain a perfect ſolution, the metal muſt be added by very little at a time, and all heat avoided: If much of the Tin is put in at once, it will only be corroded into a white powder, or reduced into a thick gelatinous ſubſtance; and if the ſolution when made, be conſiderably heated, the diſſolved Tin will ſeparate again in the like forms of a powder or gelly.

The marine acid has the greateſt affinity with Tin of all the acids, but does not diſſolve it without heat: It forſakes Mercury to unite with Tin, and when thus combined with it, volatiliſes a conſiderable portion of the metal: A ſtrong ſmoking ſpirit diſtils, which if diluted with water, grows milky and depoſites the Tin. This ſpirit, commonly diſtinguiſhed by the name of its inventor Caſſius, is prepared, by amalgamating three parts of Tin with five of Mercury, grinding the amalgam with eight parts of Mercury ſublimate, and diſtilling the mixture in a retort: The reſiduum of this operation, treated with Nitre, is the *ſudoriferum maximum* of Faber, a title which it does not very properly deſerve. Some affirm, that a ſmoking ſpirit may be obtained by putting Tin into butter of Antimony; but this does not ſucceed.

Aqua regia, or a mixture of the nitrous and marine acids, diſſolves Tin more perfectly than the one, and more readily than the other: When the nitrous has let the Tin fall in form of a white powder, if a little of the marine be added, and a moderate heat applied, the Precipitate will be taken up again and kept diſſolved. An ounce of Spirit of Sea-ſalt, mixed with only a ſcruple of Spirit of Nitre, diſſolved Tin perfectly: But upon inverting the proportions, and taking a ſcruple of the marine to an ounce of the nitrous acid, the mixture, with four ſcruples or four and a half of Tin, became thick like pap: Some more of the marine acid being gradually added, the whole was diſſolved into a clear liquor. In making the ſolution with theſe mixed acids, a ſmall portion

is accounted one of the pureſt ſorts, yielded no leſs than one fourth its weight of arſenical cryſtals; that ſome ſorts yielded more; but that Tin extracted from a particular ore which held no Arſenic, afforded none. That the cryſtals were truly arſenical, appeared from their being totally volatile; from their ſubliming (a little fixed alcaline Salt being added to abſorb the acid) into a colourleſs pellucid concrete; from the Sublimate, laid on a heated copper-plate, exhaling in fumes of a garlic ſmell; from its ſtaining the Copper white; and from its forming with Sulphur a compound ſimilar to the yellow or ſulphurated Arſenic. He found that the Arſenic was ſeparable alſo by means of Mercury: An amalgam of Tin being long triturated with water, and the powder which was waſhed off committed to ſublimation, a little Mercury came over, and bright arſenical flowers aroſe into the neck of the retort.—Theſe curious experiments are here inſerted entirely upon the credit of the authors.

Common Tin makes a crackling noiſe in bending: This is commonly ſuppoſed to be an eſſential property of pure Tin, but poſſibly it may belong only to ſuch as is arſenicated; for thoſe operations by which Arſenic is ſaid to be ſeparated, deprive it of its noiſe.

TIN. portion of blackiſh matter commonly ſeparates, and falls to the bottom (*e*).

Vegetable acids, as diſtilled Vinegar, do not diſſolve any ſenſible quantity of Tin: And hence I have been led to ſuſpect that thoſe who order a Salt to be made from Tin by diſtilled Vinegar, as all the chemiſts do, have been impoſed on by taking Tin alloyed with Lead; and that inſtead of a Salt of Tin, they obtained no other than a Sugar of Lead. Pure Tin I have digeſted. boiled, and treated in many different ways with Vinegar; and the ſame experiments I have repeated with pure calx of Tin, which ſome prefer, for this uſe, to the crude metal: But I never could obtain any thing ſaline, except an unctuous kind of extract; and the Tin employed retained its original weight—This metal is corroded by fixed alcaline Salts, whether melted along with them, or boiled in a ſolution of them.

Foils for Specula. Tin amalgamated with Mercury is uſed as a foil for looking-glaſſes, *&c.*—

Aurum Moſaicum. The Amalgam mixed with Sulphur and Sal ammoniac, and ſet to ſublime, yields a ſparkling Gold-coloured ſubſtance, called *Aurum Moſaicum*, uſed in England as a pigment: This preparation is commonly made from Quickſilver and Tin of each two parts, amalgamated together, and then thoroughly mixed with Sulphur and Sal ammoniac of each one part and a half: After ſublimation, the *Aurum* remains at the bottom——Calx of Tin is employed for

White enamels, *&c.* poliſhing Glaſs, Steel, *&c.* and makes the baſis of the white glazing of earthenware, and the white enamels: A portion of Lead is commonly mixed with the Tin, that metal remarkably promoting its calcination: The compound calx is called *Putty*. Tin may be ſtill more expeditiouſly calcined, by means of Nitre or of common Salt: When the laſt is uſed, the metal in fuſion muſt be kept continually ſtirring; and in either caſe, the calx muſt be well edulcorated with water——In the detonation of Tin with Nitre, white flowers ariſe,

Coſmetic preparations. which, collected in aludels, have been employed by ſome as a coſmetic: Magiſteries or precipitates of the metal have been uſed alſo in the ſame intention. Le Mort relates, that a Salt is obtainable, by diſtilled Vinegar, much more eaſily from the flowers, than from Tin in ſubſtance or its calx: But I have never been able to obtain this Salt from thoſe any more than from theſe——

Ruby Glaſs. The ſolution of Tin in Aqua regia is uſed as a precipitant for Gold; and the golden calx thrown down by it, for making the ruby Glaſs; an account of which may be ſeen in Kunckel's *Laboratorium*. See Gold.

Medical hiſtory. Tin has been ſuppoſed to poſſeſs conſiderable medicinal virtues; and even Boerhaave is greatly prejudiced in its favour: He ſays the Calx which precipitates ſpontaneouſly from its ſolution, is of ſingular efficacy in hypochondrical and hyſterical ſuffocations. To ſuch a character, this metal has no pretence; nor is the internal uſe of any of its preparations adviſable.

There

(*e*) *Solution of Tin.*] The ſolution is ſometimes colourleſs, ſometimes of a bluiſh, and ſometimes of a bright yellow colour, according to different circumſtances in the proceſs. Mixed with red infuſions or decoctions of animal or vegetable ſubſtances, it greatly improves their colour: The dull red of Cochineal is heightened, by a ſlight addition of this liquor, into ſcarlet; that of Brazil wood into a lovely crimſon. The ſolution of pure Tin ſcarcely exhibits any appearance of cryſtals; and if inſpiſſated to dryneſs, deliquiates in the air.

There are two preparations of it ſtill met with at times in the ſhops, though they little deſerve a place there; namely, the *antihecticum Poterii*, and *bezoardicum joviale*. The antihectic is made from equal parts of Tin and Regulus of Antimony, melted together, then pulveriſed, mixed with twice or thrice their quantity of powdered Nitre, injected into a red-hot crucible, and after the deflagration, edulcorated and dried. The bezoardic differs from this only in the manner of preparation; the mixture of Regulus of Antimony and Tin being reduced to a calx, not by detonation with Nitre, but by ſolution in acids, after the ſame manner as the *bezoardicum minerale*. TIN.

The largeſt quantities of Tin are met with in England, particularly in the county of Cornwall. There is ſome alſo in Bohemia and Saxony, and a little in the Eaſt-Indies: But in other countries, it is rare to find ſo much as to be worth the trouble of extracting. Britain is ſuppoſed to have received its name from its abounding with this metal; Tin being called in the Syriac and Chaldaic languages *Bragmanack*, that is the kingdom of Jupiter; whence are deduced, *Bratman*, *Britman*, *Britannia*. The ores of Tin are, (1.) *Zinngraupen*, or cryſtalline maſſes, commonly of a poliſhed ſurface, ſometimes of a dark brown, or violet colour, but chiefly blackiſh: Theſe are the richeſt of the Tin ores. (2.) *Zwitter*, or cryſtalline concretions reſembling the foregoing, but of a yellowiſh or ruſty colour, and leſs rich. (3.) *Zinn-ſtein*, Tin-ſtone, much poorer in Tin, and intermixed with a much larger proportion of ſtony and other mineral matters. (4.) Tin ore participating of Iron, called by the miners *Wolffram* (*f*)——Aſſays of Tin ore are made, in the common manner, with black flux. In the large way, the richer ores are barely melted down among the fuel; the poorer are previouſly ſtamped and waſhed. Natural Hiſtory.

The Engliſh and Malacca Tin are much purer than the Saxon, Bohemian, or ſuch as is prepared in any other country; but they are very rarely to be met with, at leaſt in their pure ſtate. In Holland, every Tin-founder has Engliſh ſtamps; and whatever his Tin be, the inſcription *Block Tin* makes it paſs for Engliſh. The Engliſh Tin is never worked, in England itſelf, without addition: All the wrought Tin imported from thence, we may be ſure has an admixture of ſome other metal: The unwrought may be looked upon as unalloyed.

The ſubſtances mixed with Tin are various; and every workman keeps his mixture a ſecret: Some are greatly ſuperior to others: I remember ſome perſons in England, not above three, whoſe Pewter was hard and ſonorous, and almoſt of a Silver whiteneſs. In England, I rarely found any Lead in Pewter, though we [in Germany] employ it in a large proportion: The Engliſh ſeem to avoid that metal, and very juſtly; as it injures the ſound and the colour of the Tin, and renders the veſſels made from it apt to communicate dangerous qualities Pewter.

(*f*) *Tin ore.*] Tin is rarely or never found native in the earth. Its ores are generally met with in ſmall maſſes, ſeldom exceeding two or three ounces in weight, intermingled with a large proportion of earthy matter. They are of an angular figure, moderately hard, and remarkably heavy: The richer ſorts are heavier than pure Tin itſelf. Their colour is moſt commonly brown or blackiſh: Sometimes, but very rarely, they are white and ſemitranſparent.

TIN. qualities to any kind of acid liquors or foods. The compoſition of the more eſteemed kinds of Pewter is worthy of a chymical enquiry: Without knowing their compoſition, the workman can never imitate them; and that can be determined only by chymical experiments, unleſs chance ſhould make the diſcovery. The principal ſubſtances made uſe of are, martial Regulus of Antimony, Zinc, Biſmuth, Copper, Iron, Princes-metal: Each of theſe, or two or three of them mixed together, make the Tin hard and ſonorous, and of a whiteneſs approaching to that of Silver; but much depends on the proportion: Of ſeveral of them, two or three pounds are ſufficient for an hundred weight of Tin. The Dutch put a whole pound of Lead to ten pounds of Tin.

The workmen have two methods of diſtinguiſhing the admixtures of Lead with Tin, and judging of the quantity of Lead. The firſt is by biting into it with the teeth: Pure Tin makes a crackling noiſe, and the more Lead it holds, the leſs it crackles. The other is, by caſting a ball of pure Tin; and another of the Tin to be examined, in the ſame mould: The more this laſt bullet exceeds that of the pure Tin in weight, the more Lead it contains (*g*). Lead may be diſcovered alſo by vegetable acids, as diſtilled Vinegar, Lemon-juice, *&c.* which diſſolve Lead, and have ſcarcely any action on pure Tin.

(*g*) *Examination of the purity of Tin by weight.*] Dr. Brandt has given a paper in the Swediſh Tranſactions (1744) proving, from experiment, that the fineneſs of worked Tin may be aſſayed with great accuracy from its weight, without melting, or injuring the figure of the veſſel. He found that a piece of fine Tin, weighing in the air 531 grains, loſt in water 75½: That a piece of four-ſtamped Tin, of the ſame weight (compoſed, according to the royal ordonnance, of 97 parts of fine Tin and 3 of Lead) loſt in water 72½: That the ſame weight of thrice-ſtamped Tin (in which the proportions are 83 of fine Tin to 17 of Lead) loſt in water 68½: And that the ſame quantity of double-ſtamped Tin (conſiſting of 66⅔ Tin and 23⅓ Lead) loſt 64. Upon theſe principles, when wrought Tin was brought to be aſſayed, inſtead of taking off any part of the veſſels for an experiment by fuſion, he weighed them entire in air and in water: When the loſs in water was proportionably leſs than that of the ſtandard bar, they were judged to contain too much Lead, and a further examination always ſhewed that they did. He obſerves that this method has one great advantage in common buſineſs, that large utenſils are aſſayed to a greater degree of nicety than ſmall ſpecimens; the accuracy depending on the ſenſibility of the balance, and large balances being more ſenſible, or turning with a leſs weight in proportion to the whole quantity they are loaded with, than ſmall ones: A good aſſay balance did not turn with leſs than the 7000th part of the weight upon each arm; whilſt an ordinary large balance, which bore on each arm 800 pounds, turned, when loaded, with the 25600th part of that weight.

CLASS

CLASS III. SEMIMETALS.

Metallic bodies not bearing the hammer; volatile in the fire.

I. MERCURY *or* QUICKSILVER.

MERCURY is a fluid metallic ſubſtance, not moiſtening the hands; perfectly opake; of a bright ſilver colour, reſembling Lead or Tin when melted; entirely void of taſte and ſmell; extremely diviſible (*b*); not congealable in the greateſt degree of cold hitherto known (*i*). MERCURY. Its general properties.

It is the moſt ponderous of all fluids, and of all known bodies except Gold [and Platina:] Its gravity is to that of water nearly as 14 to 1; a cubic foot of Quickſilver weighing 947 pounds, whilſt a cubic foot of water weighs but 70: It is found to be heavier in winter than in ſummer, in the proportion of eleven ounces thirty-two grains, to eleven ounces ſeven grains. In conſequence of its great denſity, it is of all fluids the coldeſt to the touch: The hand cannot be kept one quarter of an hour in a quantity of Quickſilver with ſafety. Of all fluids likewiſe it grows hotteſt (not really, but apparently) from the application of an equal external heat.

In a heat below ignition, it totally exhales in extremely thin, ſubtile, penetrating fumes, which condenſe into running Mercury again: The admiſſion of air, which changes the fumes of the other ſemimetals into a powdery calx, has not that effect upon thoſe of Quickſilver (*k*).

It

(*b*) *Mercury, extremely diviſible.*] In ſmall drops, it aſſumes a ſpherical figure. The globules divide, from the ſlighteſt touch, into numerous ſmaller ones, each further diviſible by the ſame means: The minuteſt that can be diſtinguiſhed, by the naked eye, or microſcopes, appear perfect ſpecula, very vividly reflecting the images of neighbouring objects. They loſe their ſphericity if placed upon certain metals, particularly Gold; on which the mercurial globules ſpread themſelves, like water upon moiſt bodies, and thus diſcover their great affinity with it. This fluid may be ſtrained, by moderate preſſure, through the pores of leather; and thus freed from duſt or other like impurities that may be accidentally blended with it.

(*i*) *Not congealable.*] Though it never has been known to become ſolid from cold, it has ſometimes been obſerved, in very intenſe colds, produced by artificial mixtures, to loſe conſiderably of its fluidity. There is an inſtance, in the *Acta naturæ curioſorum*, *tom.* vii. of its acquiring the conſiſtence of a ſoft Amalgam, or of a mixture of Mercury with one fourth its weight of Lead or Tin.

(*k*) *Change—into calx.*] This ſemimetal is nevertheleſs convertible, if not into a true calx, yet into the appearance of one, by a long continuance of a heat juſt not ſtrong enough to diſſipate it. By degrees it changes into a powder, at firſt aſh-coloured, afterwards yellow, at length of a bright red colour, and of an acrid taſte——This proves leſs volatile in the fire, than the Mercury in its fluid ſtate: It ſupports, for a time, even a degree of red heat. In the focus of a burning-glaſs, it is ſaid, if expoſed upon a tile, to vitrify, on a piece of charcoal to revive into running Mercury, before it exhales. Evaporated by common fire, it leaves a ſmall portion of a light brown powder; which, as Boerhaave relates (in the Philoſophical Tranſactions) bore a blaſt heat, ſwelled into a ſpongy maſs, formed with Borax a friable vitreous ſubſtance, but in cupellation vaniſhed.

By a heat no greater than that of the human body, or even of boiling water, though continued for ſome years, only a ſmall por-

MERCURY. tion of the Mercury is converted into powder: The powder thus obtained appears of a dark greyiſh or black colour. Conſtant triture or agitation produce a change ſimilar to that effected by this low degree of heat, and in a far ſhorter time.

As Mercury aſſumes theſe adventitious forms, without communication with the air, or the loſs of any of its parts, it recovers its own without addition: Both the red and the black powders, expoſed barely to a fire ſufficient to elevate them, return into fluid Mercury again. The red powder has been revived into Quickſilver by ſimply grinding it in a glaſs mortar.

Repetitions of theſe operations occaſion no permanent change in the Quickſilver. Boerhaave had the patience to diſtil Mercury five hundred and eleven times ſucceſſively; to keep it in conſtant agitation for many months; to digeſt it for upwards of fifteen years together, in low degrees of heat, both in open and in cloſe veſſels, by itſelf and in conjunction with other metallic ſubſtances; and received from all his labours only this reſult, that Mercury is not by any of thoſe means to be changed. It were to be wiſhed, that this indefatigable enquirer had purſued proceſſes more agreeable to the general doctrine of thoſe who pretend to have changed it: It is not by low degrees of heat, but by the ſtrongeſt it can ſuſtain, that the philoſophers by fire think to lay fetters upon this fugitive metal.

Dr. Brandt amalgamated fine Gold with a large proportion of Quickſiver, and having ſtrained off the ſuperfluous Mercury, digeſted the Amalgam, in a cloſe ſtopt veſſel, for two months, with ſuch a heat, that a part of the Quickſilver ſublimed into the neck of the Glaſs. The matter being then ground with twice its weight of Sulphur, and urged with a gradual fire in a crucible, a ſpongy calx remained, which being melted with Borax, and afterwards kept in fuſion by itſelf for half an hour in a very violent fire, ſtill retained ſo much of the Quickſilver, as to prove brittle under the hammer, and appear internally of a leaden hue. The metal being amalgamated with freſh Mercury, the Amalgam again ground with Sulphur, and expoſed to an intenſe fire, a ſpongy calx remained as before.——This calx being digeſted in two or three freſh parcels of Aqua regia, a ſmall portion of whitiſh matter remained at laſt undiſſolved. The paper which covered the cylindrical Glaſs wherein the digeſtion was performed, contracted from the vapours a deep green circular ſpot in the middle, with a ſmaller red one at the ſide; whereas the Aqua regis digeſted in the ſame manner by itſelf, or with Gold, or with Mercury, gave no ſtain. The firſt ſolution, on the addition of Oil of Tartar per deliquium, grew red as blood; on ſtanding, it depoſited, firſt a little yellow calx like Aurum Fulminans, afterwards a bright matter like fine Gold, and at laſt a paler Precipitate inclining to green; its own deep red colour and tranſparency continuing unchanged: Being now committed to diſtillation, a colourleſs liquor aroſe; and the reſiduum, perfectly exſiccated, yielded on edulcoration a yellow calx of Gold, which the alcaline Lixivium had been unable to precipitate. The ſecond ſolution turned green on the admixture of the alcaline liquor, and let fall a white Precipitate, which edulcorated, looked black and brown——The ſeveral precipitates were calcined with twice their weight of Sulphur, and then melted, with four times their weight of Flint and twelve of Pot-aſh, in a fire vehemently excited by bellows. The ſcoria appeared of a golden colour, which on pulverization and edulcoration vaniſhed. At the bottom was a Regulus, which looked bright like the pureſt Gold, but was not perfectly malleable: Broke, it appeared internally white, and the white part amounted to at leaſt one third its bulk. Beſides this lump of metal, there were ſeveral ſmaller ones, white like Silver, and ſoft as Lead——This remarkable experiment was made in the Royal Elaboratory at Holm, and communicated in the *Acta literaria ſuecicæ* for the year 1731. The author concludes from it, that a portion of Quickſilver, and a very conſiderable one, is detained and fixed by digeſtion with Gold, ſo as not to be diſſipable by the moſt intenſe fires. He expreſsly mentions the Gold, made uſe of, being highly refined; and though he does not inform us what the Mercury was, it ſeems hard to ſuſpect that this accurate and expert chymiſt ſhould employ, for ſuch a curious purpoſe, Mercury whoſe purity from Lead, or the other ſubſtances with which it is ſometimes ſophiſticated, he had not duly examined.

Some have pretended to convert Quick-

ſilver

It diſſolves in all the mineral acids, but with different degrees of facility; and proves itſelf a menſtruum for ſundry metallic bodies (*l*). It has the greateſt affinity with Gold; adhering to and diſſolving that metal the moſt readily

MERCURY. A menſtruum for metals.

ſilver into a limpid water, capable of diſſolving metals, and producing extraordinary effects on them. This is attempted by expoſing the Mercury to the ſudden action of a ſtrong fire: A tall iron veſſel, furniſhed with a capacious head, aludels, and a recipient, is heated to a white heat, and the Quickſilver injected, by a very ſmall quantity at a time, through an aperture made for that purpoſe near the top. Kunckel has ſhewn the fallacy of this proceſs; that the liquor ſometimes collected in the receiver is no other than a merely aqueous one, accidentally contained in the Mercury or forced out from the luting, in no reſpect different from common water. I have oftener than once repeated the experiment with pure dry Mercury, without being able to obtain the leaſt appearance of any moiſture.

(*l*) *A menſtruum for metals.*] There are three metallic bodies, which Mercury does not diſſolve or unite with; Iron, Arſenic, and the ſemimetal called Nickel. It will in ſome caſes abſorb metals, particularly Gold and Silver, from their ſolutions both in acid and in alcaline liquors; but does not act upon any metal when combined with Sulphur, nor on precipitates made by alcalies, nor on calces prepared by fire. Whatever metal it is united with, it conſtantly preſerves its own white colour.

Saline liquors diſſolve only a certain quantity of metals; which they carry with them through all the ſtrainers that the liquor is capable of paſſing by itſelf. Mercury unites with any proportions, forming, with different quantities, amalgams of different degrees of conſiſtence: From the fluid ones, greateſt part of the Quickſilver may be ſeparated by colature. Biſmuth is the only metallic body, which is ſo far attenuated by Mercury, as to paſs through leather with it in any conſiderable quantity; and Lead is the only one, to which Biſmuth communicates that property in any conſiderable degree.

Biſmuth promotes the action of Mercury upon Lead in a remarkable manner. Quickſilver impregnated with one fourth, one eighth, one twelfth its weight of Biſmuth, diſſolves maſſes of Lead, in a gentle warmth; without the agitation, or triture, or comminution, or melting heat, neceſſary for uniting Lead with pure Mercury. Theſe experiments I made, ſome years ago, on a report, that an eminent French ſurgeon had diſcovered a ſafe menſtruum for diſſolving pieces of Lead lodged in cavities of the human body.

On triturating or digeſting amalgams for a length of time, a blackiſh or duſky coloured powder ariſes to the ſurface, and may be readily waſhed off by water. Some of the chymiſts have imagined, that the amalgamated metal is here reſolved into its conſtituent parts. But pure Mercury, as we have already ſeen, is convertible by itſelf, on the ſame treatment, into a ſimilar powder; and the metallic particles, united in this proceſs with the mercurial powder, are found to be no other than the metal in its entire ſubſtance. Some metals ſeparate much more ſlowly and difficultly than others; Gold and Silver the moſt ſo.

It is ſaid, that the Quickſilver, in theſe powders, proves more volatile than in its common fluid ſtate; that if the powder, which ſeparates from an amalgam of Lead, be committed to diſtillation with Vinegar in a tall veſſel, the Mercury will ariſe before the Vinegar boils; that by a like artifice, Quickſilver may be made to diſtil even in a leſs degree of heat than that of the human body. This I relate upon the authority of Boerhaave; having never been able myſelf, though the trials were often repeated, to ſucceed.

On expoſing amalgams to a fire gradually raiſed to ignition, the Mercury freely exhales, leaving the metal behind in form of a very ſubtile powder. A ſmall portion of ſome of the metals generally ariſes along with the Quickſilver. Thus Mercury diſtilled from Lead, Biſmuth or Tin, appears leſs bright than before, ſtains paper black, ſometimes exhibits a ſkin upon the ſurface, and

MERCURY. readily of all. It unites eaſily alſo with Silver; leſs eaſily with Lead; ſtill leſs ſo with Tin; very difficultly with Copper; moſt difficultly of all with Iron, to which it ſeems to have an inſuperable repugnance. It does not eaſily take up Biſmuth or Regulus of Antimony, unleſs they are previouſly mingled with other metals, or diſpoſed to unite with it by particular managements: After it has been combined with either of theſe, it throws them out again upon digeſtion: Biſmuth nevertheleſs diſpoſes ſome other metals, particularly Lead, to ſuch an intimate union with the Mercury, as to paſs along with it through the pores of leather. Quickſilver mingles alſo with various ſaline ſubſtances, and with Sulphur; with which laſt it forms a black maſs called *æthiops*, which changes, on ſublimation, into a red one called Cinnabar.

How to be kept. The gravity and diviſibility of Mercury renders great precaution neceſſary in regard to the veſſels in which any conſiderable quantities are exported or kept; the ſmalleſt hole or crack permitting it to eſcape. Metalline veſſels are improper; and glaſs or earthen ones are too liable to break. The veſſels commonly made uſe of are, either compact wooden ones; or ſtrong thick leather, in which all the Spaniſh Mercury is brought from America; or thick glaſs bottles, or turned wooden boxes, ſecured in leather.

Methods of judging of its purity. There are ſundry methods mentioned in books for judging of the goodneſs of Quickſilver; but they ſeem to be built upon vain conceits about the Mercuries of metals. Some direct the Quickſilver to be expoſed to the fire, and the colour of its fumes examined: Green or yellow fumes denote a ſolar, bluiſh ones a lunar, and reddiſh brown a venereal Mercury: A jovial Mercury is diſtinguiſhed by a whitiſh colour of the fumes, a ſaturnine by an aſh-grey colour, and a martial by a dark yellow. Others, diſregarding the fumes, attend only to the ſpot which remains upon evaporating ſome of the Quickſilver in a Silver ſpoon: If the ſpot is yellow or white, the Mercury is held to be good, the yellow colour being ſuppoſed to proceed from Gold, and the white from Silver: A brown or black ſpot on the other hand is a mark that the Mercury is of a bad kind; theſe colours proceeding from Copper or ſome of the baſer metals.

We need not however be ſolicitous about the colour either of the fumes or the reſiduum: If any powdery or any actual matter at all is left, we may be ſure that the Quickſilver is adulterated, moſt probably with Lead; a conſiderable portion of that metal being miſcible with Mercury, by the mediation of Biſmuth, not only without deſtroying its fluidity, but ſo as to paſs with it, by preſſure, through leather. It is not needful to ſuffer the Mercury to exhale in

and does not run freely or into round globules. Boyle relates, that he has obſerved the weight of the Mercury ſenſibly increaſed by diſtillation from Lead, and this when only a moderate fire was made uſe of.

Mercury amalgamated with ſtellated Regulus of Antimony, digeſted for ſome hours and then diſtilled off, is ſaid to become, by a few repetitions of the proceſs, more ponderous and more active; the animated or philoſophic Mercuries of ſome of the alchymiſts, are ſuppoſed to have been Quickſilver thus prepared. By the ſame or by ſimilar proceſſes ſeem to have been obtained the curious Mercuries which Boyle declares he was in poſſeſſion of and made himſelf; which "were conſiderably heavier in ſpecie "than common Quickſilver——diſſolved "Gold more readily—grew hot with Gold, "ſo as to be offenſive to the hand—and "elevated Gold in diſtillation." See his producibility of chymical principles, p. 209. *&c.* and the Philoſophical Tranſactions, N° 122.

in the air, in order to diſcover its adulteration; it may be all ſaved, by diſtil- MERCURY.
ling it in a retort: If it totally ariſes, without leaving any reſiduum, we may
be ſatisfied of its purity. The abuſe may be detected alſo ſtill more commodi-
ouſly and expeditiouſly, without a retort, or a Silver ſpoon, or a crucible, or
fire: If a little of the Quickſilver be diſſolved in Aqua fortis, a white precipi-
tation will preſently betray the Lead. The external marks of its purity are its
whiteneſs and brightneſs, and the facility of its running when a little is dropt
on a table, *&c.* The marks of its impurity are, its appearing duſty, contract-
ing a ſkin on the ſurface, running ſlowly, and leaving a droſſy matter behind.

There are different methods of purifying Quickſilver; as ſtraining through Purification.
leather; trituration or ablution with Vinegar, with Vinegar and Salt, with
Sope-leys, with rectified Spirit of Wine, and with Aqua fortis; and diſtilla-
tion, either without addition, or with alcaline Salts, Quicklime, or Iron filings.
When Quickſilver is only ſuperficially mixed with duſt or earthy powders,
ſtraining through leather is ſufficient for its purification: If any foulneſs ſtill
remains, Spirit of Wine will waſh it off: Unctuous or oily impurities require
ablution with Sope-leys. Lead and Biſmuth are moſt effectually ſeparated by
making the Mercury into an *æthiops* with a ſufficient quantity of Sulphur, and
reviving it again from the *æthiops* by diſtillation with twice its quantity of
Quicklime, alcaline Salt or Iron filings: The Mercury alone will diſtill, and
leave all its impurities behind: Sulphureous, antimonial, and other like ad-
mixtures are to be ſeparated by the ſame means. The purification by Aqua
fortis is performed by taking only a ſmall quantity of the acid to a large one
of Mercury; grinding them diligently together, and then waſhing the Quick-
ſilver with water. When Mercury is combined with Sulphur into Cinnabar,
the revivification of it does not well ſucceed with alcaline Salts; by fixed alca-
lies, the Sulphur is very difficultly, and not perfectly, abſorbed; to volatile
alcalies, it does not yield at all: On the other hand it is obſervable, that me-
tallic bodies, as Iron, Lead, Tin, Regulus of Antimony, readily detain the
Sulphur in diſtillation, and ſuffer the Mercury to ariſe pure.

The largeſt quantities of Mercury are employed for metallurgical operations: Uſes.
Gold and Silver are extracted, in the Spaniſh Weſt-Indies, from their ores or
matrices, by amalgamation with Mercury; and both metals are recovered by
the ſame means, when blended in minute particles with earthy matters, as in
filing or working them. Amalgamated with Tin, it makes the foil for look-
ing-glaſſes, and reflecting balls. It is uſed alſo for gilding on Silver, for ana-
tomical injections, for weather-glaſſes, and ſundry other purpoſes. In vacuo,
it appears luminous, and is then called the mercurial Phoſphorus.

Quickſilver, conſidered as a medicine, is a ſpecific againſt the venereal diſ- Medical hiſ-
eaſe, worms, lice, and all kinds of inſects: The venereal diſtemper is not per- tory.
haps to be radically cured without it, but againſt inſects there are other reme-
dies equally if not more effectual. It is commonly ſuppoſed to have, of itſelf,
no poiſonous quality; but it appears, from experience, manifeſtly prejudicial
to the nerves and the bones. Its ill effects are moſt obſervable in thoſe, who
are expoſed to its fumes; which fumes are no other than perfect Quickſilver,
as any one may be convinced by receiving them on a piece of moiſt leather or
cloth, upon which they will reunite into little globules of Mercury. Moſt
people

MERCURY. people admit a pernicious quality in the fumes, though they deny it to the Quickſilver; not conſidering that the fumes are only the Quickſilver itſelf, divided but not altered by the heat. Even mercurial ointments applied externally have occaſioned contractions of the limbs, corroſions of the bones, and other dangerous conſequences. How ſoon do the miners feel its ill effects, though they neither anoint with it, nor ſwallow it, nor are expoſed to the fumes into which it is reſolved by fire! they firſt become paralytic, and fall afterwards into a ſalivation: Their teeth drop out: Violent pains in the whole body, particularly in the bones, and at length death, ſucceed. It may be proper to obſerve, that the Spaniſh phyſicians treat theſe patients in a different method from that purſued among us and in other countries: They expoſe them frequently for a conſiderable length of time to the open air, and give internally nothing but abſorbents.

Quickſilver is employed medicinally, in a great variety of forms; in its crude ſtate; diſſolved in different menſtrua; ſublimed with them; precipitated from them. Crude Quickſilver is uſed either by itſelf, or in compoſition with other ſubſtances: By itſelf, in large quantity, for forcing open inteſtinal obſtructions: Combined with Sulphur, into *æthiops mineral*; with powdered Antimony into an *antimonial æthiops*; with different unctuous matters into *ointments* and *plaſters* both for venereal complaints and cutaneous inſects; with gums and gummy reſins into *venereal pills*. The beſt method of making the æthiops mineral is, to put the flowers of Sulphur into an iron mortar over the fire, till they begin to melt; then to remove the mortar from the fire, and ſqueeze in the Mercury through leather; and grind them well together with a warm iron peſtle. By this method they will unite more eaſily, and more perfectly, than by trituration without heat——Some take Quickſilver, powdered Antimony, Gum guaiacum, and make them into a maſs with extract of liquorice. Du Moulin, an Engliſh phyſician, abſtained from all the mercurial preparations made with Salts, and uſed only the following pills: Two ounces of Quickſilver were killed with three ounces of Venice Turpentine, then mixed with powdered Aloes, Scammony and Colocynth, of each two ounces, and a dram of Oil of Cloves; and the whole made into a maſs with a proper quantity of Syrup of Buckthorn. Some grind the Quickſilver for a length of time with Sugar, and diſſolve it in water. Some boil Quickſilver alone in water, and thus obtain a medicine againſt worms: If the diſtilled waters of Saint-johns-wort, Meadow-ſweet, or Graſs-roots be made uſe of, the liquor is called *aqua hermetica*. The Mercury, by this treatment, does not appear to loſe any thing of its weight; but the water is found to have different effects from thoſe of plain water.

Chymical preparations. The chymical preparations of Mercury are very numerous, and moſt of them unſafe or unneceſſary. Frederic Hoffman the elder juſtly obſerves, that he who has two good preparations of Mercury needs no more: And in effect, if we have but good *Mercurius dulcis* and *Cinnabar* for internal uſe, and corroſive Sublimate and red Precipitate for external, all others are ſuperfluous. Helmont alledges, that ſo long as Quickſilver can be revived, it is no ſafe medicine; but if this was true, no mercurial medicine could be ſafe. Mercury eludes all our attempts to analyſe or deſtroy it: Whatever ſubſtances it is combined

combined with, whatever operations it is ſubmitted to, it ſtill remains Mercury: We can transform it into a variety of ſhapes, but the bare action of heat or the ſeparation of the ſubſtances joined to it, conſtantly reſtores it again to its own. Thoſe who affirm Mercury to have been in certain operations irreducibly deſtroyed, ſeem to have been miſled by an opinion, ſtill too common, that the ſeveral ſubſtances employed in making a preparation, are retained in the product. How many ſtill believe, that Aqua fortis, diſtilled from a mixture of Vitriol and Nitre, contains the vitriolic as well as the nitrous acid? That corroſive Sublimate, made with Vitriol, Nitre, and Sea-ſalt, contains the acids of the two firſt as well as of the laſt? though it is certain, that the vitriolic acid in the one caſe, and both the vitriolic and nitrous in the other, remain at the bottom of the diſtilling or ſubliming veſſel. In like manner Butter of Antimony has been ſuppoſed to contain the Mercury made uſe of in making it, and a Precipitate from the Butter has been diſtinguiſhed by the name of *Mercurius vitæ:* No Mercury is indeed reducible from theſe preparations, but if we examine the matter left in the retort, all the Mercury employed will be found there. MERCURY.

Solution of Mercury is commonly made in Spirit of Nitre or Aqua fortis: A quantity of the acid, more or leſs in proportion to its ſtrength, is poured upon the Quickſilver, and a gentle warmth applied till the whole of the Mercury is diſſolved. If the ſolution is very ſtrong of the Mercury, a part will cryſtallize upon the removal of the heat. Both the ſolution and the cryſtals are employed for other preparations——Mercury is diſſolved alſo in Oil of Vitriol; but for this purpoſe a conſiderable heat is required. Boerhaave calls this ſolution the *ignis gehennæ* or *infernalis* of Paracelſus; and imagines, that when concentrated, it is the *aurum horizontale* of Helmont. If the liquor be abſtracted to dryneſs, a white maſs remains, which on the affuſion of water aſſumes a fine yellow colour, and when duly edulcorated is called *turpethum minerale*, or *mercurius præcipitatus flavus* (*m*). Solution.

The

(*m*) *Menſtrua of Mercury.*] Aqua fortis, of ſuch a degree of ſtrength as to diſſolve half its weight of Silver, diſſolves with eaſe above equal its weight of Quickſilver, into a limpid liquor, intenſely corroſive. The ſolution inſpiſſated, or the cryſtals, aſſume, on being moderately calcined, a ſparkling red colour——Oil of Vitriol, boiled upon Mercury to dryneſs, corrodes about an equal weight or more, into a ſaline maſs partially ſoluble in water. Kunckel obſerves, that by pouring on this white maſs a very little water at a time, ſo as not to turn it yellow, nearly the whole will be diſſolved. A total ſolution may likewiſe be obtained by repeating the coction in freſh Oil of Vitriol——The marine acid does not act upon Mercury, unleſs highly concentrated and reſolved into fume; in which ſtate it corrodes a large proportion into a colourleſs cryſtalline maſs, which according to the quantity of acid proves either pellucid, diſſoluble in water, and extremely cauſtic; or opake, indiſſoluble and inſipid——It has the greateſt affinity with the marine acid, and the leaſt with the nitrous. Silver is the only metallic body beſides, which is precipitated from the nitrous by the vitriolic, and from the vitriolic by the marine: And hence Mercury may by this means be effectually purified from admixtures of all other metals, though the proceſs is too operoſe for common uſes——Alcaline Salts precipitate Mercury from all acids. Fixed alcalies, calcined with animal coals, if added in a larger quantity than is ſufficient for the precipitation, rediſſolve what they had before thrown down: Volatile alcalies

 have

MERCURY.

Corrosive Sublimate.

The mercurial Sublimates are of two kinds; those made with the acid of common Salt, and those with Sulphur. To the former belong corrosive Sublimate, Mercurius dulcis, and the mercurial Panacea; the first of which is the basis of the other two——Corrosive Sublimate is no other than crystals of Mercury made with the concentrated marine acid, by means of sublimation; some other substances being added, to facilitate the union of that acid with the Mercury. For combining Quicksilver with the acid of Sea-salt, it is necessary, that either the Mercury itself be previously dissolved in the nitrous or vitriolic acids; in which case the marine will attract it from both; or that the marine acid be united with some fixt body that may render it capable of bearing a considerable heat, as it naturally is in common Salt: If Mercury and common Salt were mixed together and exposed to the fire, the Mercury would distill by itself; but if the nitrous or vitriolic acids are added, these extricate the marine, which now corrodes the Mercury, and arises along with it in form of a white crystalline mass. There are many different methods of preparing this Sublimate, as (1.) from Mercury, common Salt, Nitre and Vitriol, (2.) from Mercury, common Salt and Vitriol, (3.) from Mercury, common Salt and Spirit of Nitre, (4.) from solution of Mercury in Aqua fortis, and common Salt, (5.) from solution of Mercury in Aqua fortis, and Spirit of Salt, or from the white Precipitate, (6.) from Mercury, common Salt, Nitre and Oil of Vitriol, (7.) from edulcorated Turpeth mineral and common Salt, (8.) from red Precipitate, common Salt, and Oil of Vitriol, (9.) from edulcorated Turpeth mineral and Spirit of Salt, (10.) from Mercury, Sal ammoniac and Oil of Vitriol, *&c.* The sublimates obtained from all these mixtures may be taken indiscriminately for any common uses; though in some of the nicer experiments, considerable differences are observed among them, especially betwixt those made with or without Nitre or its acid, and more particularly where the sublimation is repeated with this or that addition.

The common method of making sublimate, at Venice, London, and Amsterdam, where several hundred weight are sublimed at once in eight large glasses placed in one furnace, is, according to Tachenius's account, as follows. Two hundred and eighty pounds of Quicksilver, four hundred pounds of Vitriol calcined to redness, two hundred pounds of Nitre, the same quantity of common Salt, and fifty pounds of the Caput Mortuum remaining after a former sublimation, or in want of this, of the Caput Mortuum of Aqua fortis, making in all eleven hundred and thirty pounds, are well ground and mixed together, and set to sublime in proper glasses placed on warm ashes: The fire is increased by degrees, and continued for five days and nights. In the making of such large quantities, some little precautions are necessary, which those constantly employed herein are best acquainted with; the principal are, the due mixture of the ingredients, which in some places is performed in the same manner as that of the ingredients for gunpowder; that a helm and receiver be adapted

have no such effect——Vegetable acids do not act in the least upon Mercury in its metallic state; but sparingly dissolve it when reduced by fire into a powdery form, and when precipitated by alcalies from the mineral acids——It is said, that when triturated with Sugar and a small proportion of essential Oil, it dissolves in water; and that it gives a violet tincture to pure essential Oils, particularly that of Juniper-berries.

adapted to the ſubliming glaſs, to ſave a little ſpirit which ariſes; that the fire be not raiſed too haſtily; that when the Sublimate begins to form, the aſhes be removed from the ſides of the glaſs, or the glaſs cautiouſly lifted up a little from the aſhes; and that the elaboratory have a good chimney, by which the noxious fumes may freely paſs off. The quantities above-mentioned yield commonly three hundred and ſixty pounds of Sublimate, the two hundred and eighty pounds of Mercury gaining eighty from the acid: So that Sublimate conſiſts of about ſeven parts of Quickſilver, and two of marine acid. The makers of Sublimate in France, as I have obſerved in my travels in that kingdom, employ in one operation but twenty pounds of Mercury: They diſſolve the Mercury in Aqua fortis, evaporate the ſolution to dryneſs, mix with the dry matter twenty pounds of decrepitated Sea-ſalt and ſixty pounds of calcined Vitriol; and then proceed to ſublimation. MERCURY.

This preparation is violently corroſive; and poiſonous in a high degree to all animals. Solutions of it in water are employed externally for venereal and other foul ulcers. It is mixed with Antimony for making the antimonial Butter and Cinnabar, with Tin for the *Spiritus fumans caſſii*, &c. It is uſed alſo in ſome mechanic buſineſſes, particularly by the goldſmiths: Injected on ſome ſorts of brittle Gold in fuſion, it conſumes the impurities, and renders the metal malleable: See page 41. Some have affirmed that Sublimate is often adulterated with Arſenic; and propoſed its turning black with alcaline Lixivia as a means of diſcovering the abuſe. But this adulteration is abſolutely impracticable, Arſenic being incapable of ariſing in ſublimation along with Mercury ſublimate. See Arſenic. If Sublimate indeed was ſold in powder, the adulteration might be practiſed; but we may be always certain that the cryſtalline cakes have ſuffered no ſuch abuſe. With regard to the turning black with alcalies, it is ſo far from being a mark of Arſenic, that the beſt and pureſt Mercurius dulcis changes to a blackiſh grey colour both with fixt and volatile alcalies.

Mercurius dulcis, called alſo *calomelas*, *manna metallorum*, *panchymagogum minerale*, *aquila alba*, and *draco mitigatus*, is a combination of corroſive Sublimate with freſh Mercury; or more properly, it is a combination of the marine acid with as much Mercury as that acid is capable of corroding or uniting with; whilſt the corroſive Sublimate is a combination of Mercury with as much of the acid as it is capable of abſorbing. The *Mercurius dulcis* is ſometimes called *Mercurius ſublimatus dulcis*; but the title *ſublimatus* is better omitted, leſt the foregoing corroſive Sublimate ſhould chance to be confounded with the mild one: a miſtake which once actually happened, and which coſt the patient his life: The perſon who made up the preſcription pleaded in excuſe, that he knew but of one *Mercurius ſublimatus*, and did not think it ſafe to taſte whether it was ſweet or not. Mercurius dulcis.

In making *Mercurius dulcis*, the principal point is, to take crude Quickſilver enough to fully ſatiate the acid of the corroſive Sublimate. Some are accuſtomed to employ an under proportion of Quickſilver, with a view to render the preparation of a fine white colour and cryſtalline appearance: But theſe qualities, far from being of any advantage to it, or any marks of its goodneſs, denote rather that it continues in ſome degree corroſive: It is not the

MERCURY. colour or cryſtalline form we are to regard; if it is clean, and perfectly inſipid, it is a good *Mercurius dulcis*. The Mercury ſhould be taken in equal quantity to the Sublimate, or at leaſt three parts of Mercury to four of Sublimate; the ingredients thoroughly mixed together in a glaſs or ſtone mortar; then poured through a long funnel into a glaſs body, and ſublimed: All the matter which ariſes is to be reduced again into powder, and ſublimed a ſecond time in a freſh matras. The managements to be obſerved in the proceſs are, to ſet the glaſs pretty deep in the ſand; not to raiſe the fire too haſtily at firſt; and as ſoon as the ſuperfluous Quickſilver has ariſen, to remove part of the ſand all round the ſides. The ſublimation may be repeated three or four times or oftner, but this nowiſe contributes to the perfection of the medicine: If there is Mercury enough, a good *Mercurius dulcis* may be made by one ſublimation; and if there is not, no number of ſublimations will ſupply the deficiency. *Mercurius dulcis* might be made even by one ſingle operation, from the ingredients which corroſive Sublimate is prepared from, by taking the Mercury in a ſufficiently large quantity. Some, after having by two ſublimations obtained a duly dulcified Sublimate, have ſublimed it a third time from a little common Salt and Caput Mortuum of Vitriol: This renders it cryſtalline, but at the ſame time makes it corroſive again by ſupplying freſh acid.

Mercurial Panacea. The mercurial Panacea is a Mercurius dulcis, ſublimed eight or nine times or oftner in freſh glaſſes, then digeſted in Balneo with rectified Spirit of Wine for a fortnight, and afterwards dried. There is alſo a black mercurial Panacea, or a violet coloured Mercury ſublimate, prepared from Mercury, Sal ammoniac and Sulphur by repeated ſublimations; but it is not in uſe. It is pretty extraordinary, that two volatile ſubſtances, often ſublimed together, ſhould fix one another: That corroſive Sublimate is thus fixed by Sal ammoniac, ſo as no longer to ſublime, appears a paradox, but is a fact.

Cinnabar of Antimony. There are two mercurial Sublimates made with Sulphur, not diſtinguiſhed however by the name of Sublimates, but of Cinnabars, factitious and antimonial. Both Cinnabars conſiſt wholly of Mercury and Sulphur, and differ only in the manner of combining them together. For the factitious Cinnabar, the Mercury and Sulphur are both employed in their pure ſtate: But for the Cinnabar of Antimony, the Quickſilver is previouſly united with marine acid into corroſive Sublimate, and the Sulphur is united with Regulus of Antimony into crude Antimony. The uſe of taking the ingredients ſo combined does not regard the improvement of the Cinnabar, but the obtaining of another preparation at the ſame time: The acid of the Sublimate forſakes the Mercury and corrodes the antimonial Regulus, and theſe two, diſtilling together, form what is called Butter of Antimony: Then follow the Mercury and Sulphur combined into Cinnabar. The antimonial Cinnabar is commonly of a worſe colour than the factitious, inclining to blackiſh, from the proportion of Sulphur being ſomewhat larger: When its colour turns out the beſt, it is not at all ſuperior to the other.

Factitious Cinnabar. Factitious Cinnabar, called ſimply Cinnabar or Vermilion, is no where prepared in the way of trade but in Holland: The Dutch have not themſelves one grain of either of the ingredients; but procure them, with ſundry others, from us [in Germany]; and then laugh at our ſimplicity in giving up to them ſuch profitable

profitable manufactures——To one part of Sulphur, they take from ſix to eight parts of Quickſilver; and having melted the Sulphur, ſtir in the Mercury, and mix them thoroughly together: This mixture is made in the quantity of a hundred weight at a time. For ſubliming veſſels, they uſe large, oblong, coated glaſs, or earthen jars nearly of the ſame width from end to end: Theſe are hung in a furnace by a ſtrong rim of Iron. When the matter is put in, the mouth of the veſſel is covered, the fire increaſed by degrees, and continued for ſeveral hours till all the Cinnabar has ſublimed; care being taken to introduce at times an Iron rod to keep the middle clear, otherwiſe the Cinnabar concreting there and ſtopping up the paſſage, would infallibly burſt the veſſels. I remember an accident of this kind in the royal garden at Paris: Mr. Boulduc had contrived a method by which he ſaid Cinnabar might be ſublimed more expeditiouſly than in the common way; but the blocking up of the neck of the veſſel not being provided againſt, the whole flew in pieces at once, with a horrible exploſion (*n*). MERCURY.

The Cinnabar ſublimes in large cakes, of a dark red colour, and a needled or ſtriated texture like Antimony. The Dutch grind it into powder in mills made for that uſe; which no ſtranger is permitted to ſee: Though I have been ſeveral times in Holland, and ſpared no pains or expences, I have never been able to obtain any further information about this part of the manufacture, than that Urine or Brandy are added in the grinding. The painters find, that the Vermilion ground by the Dutch dries ſooner than any other, and hence ſuſpect that ſome foreign matter is mixed with it; pure Vermilion drying exceeding ſlowly: In ſome parcels, white or red Lead are ſaid to have been diſcovered, though ſuch as I examined gave no marks of either of theſe, only a ſmall portion of brown earth being left upon reſubliming it. However this may be, we ſhould always chuſe, for medicinal uſe at leaſt, Cinnabar in the cake, as being leſs liable to adulteration than that which is ground into powder. Its total evaporation in the fire may be looked upon as a ſure mark of its purity.

There are ſundry mercurial Precipitates, properly ſo called, as being prepared by precipitating Mercury from its ſolutions in acids by means of certain additions. Sea-ſalt, Sal ammoniac, or Spirit of Salt, added to a ſolution of Mercury in Aqua fortis, throw down a white Precipitate, differing little from corroſive Sublimate; the Mercury forſaking the nitrous acid in which it was diſſolved, and uniting with the marine into a concrete leſs diſſoluble. Spirit of Sal ammoniac, added to the ſame ſolution, throws down a white Precipitate much leſs corroſive. Corroſive Sublimate, diſſolved in water, yields alſo with volatile alcalies a white Precipitate mild like the preceeding. Solution of Sublimate, mixed with a ſolution of crude Sal ammoniac, depoſites upon adding fixt Mercurial Precipitates.

(*n*) *Cinnabar.*] Hoffman gives a curious method of making Cinnabar without ſublimation; by ſhaking or digeſting a little Mercury with volatile tincture of Sulphur: The Mercury readily imbibes the Sulphur from the volatile Spirit, and forms with it a deep red powder, not inferior in colour to the Cinnabar prepared in the common manner. I have varied the experiment, by employing, inſtead of the volatile tincture, the more eaſily parable ſolutions of Sulphur made with fixt alcalies, and with Quicklime; and with theſe alſo I have obtained a perfect Cinnabar, of a brighter or darker colour according to the proportion of Sulphur.

MERCURY. fixt alcalies a like white Precipitate; but if fixed alcalies are added to a ſolution of Sublimate alone, the Precipitate is of an orange colour. A ſolution of Mercury in Aqua fortis yields, like the ſolution of Sublimate, an orange coloured Precipitate both with fixed alcaline Salts and with Lime-water: A Precipitate made from it with warm urine is of a reddiſh or roſe colour.

Red Precipitate. Solutions of Mercury inſpiſſated are called alſo, improperly, Precipitates. Red Precipitate is prepared by evaporating a ſolution of Mercury made in Aqua fortis, and gently calcining the remaining dry matter, till it acquires a ſparkling yellowiſh-red colour: The greateſt quantities of this preparation are made by the manufacturers of Sublimate, who ſave the expence of Aqua fortis by employing the ſpirit which ariſes in that operation. If the red Precipitate be reduced into fine powder, and freſh parcels of rectified Spirit of Wine diſtilled off from it or burnt upon it, its corroſiveneſs is conſiderably abated; a part of the acid being diſſipated in the burning, or ariſing with the ſpirit in diſtillation, ſo as to change it into a *Spiritus nitri dulcis:* The preparation is now called *Mercurius præcipitatus corollatus*, or *arcanum corallinum*. In England, the red Precipitate is dulcified alſo by grinding it on a levigating ſtone with a few drops of Oil of Tartar per deliquium, and afterwards burning rectified ſpirit upon it: Thus prepared, it is called *pulvis principis*. In ſome places a green Precipitate is made from ſolution of Mercury in Aqua fortis, by adding a ſolution of Verdegris: This is named, *lacerta viridis*, and *antivenereum mercuriale*: The Copper renders it too dangerous for any internal uſe——The yellow Precipitate, called *turpeth mineral*, is prepared by boiling Quickſilver with an equal weight or more of Oil of Vitriol in a retort, and continuing the fire till the matter has become thoroughly dry and the veſſel red hot. Warm water poured on the white maſs which remains, turns it inſtantly yellow; after which the matter is to be waſhed with freſh parcels of water, till the liquor comes off perfectly inſipid. If Oil of Vitriol be ſeveral times drawn over from Mercury, the maſs proves conſiderably fixed in the fire: It melts without evaporating, and whilſt in fuſion looks like blood.

Turpeth mineral.

Calx of Mercury per ſe. The *mercurius præcipitatus per ſe* is properly a calx of Mercury. It is prepared by digeſting the Mercury for a length of time, ſeveral weeks or even months in a flat-bottomed glaſs, ſlightly ſtopt or covered with paper to keep out duſt, but by no means luted or hermetically ſealed as ſome direct, a communication with the external air being neceſſary to the ſucceſs of the proceſs: No more Quickſilver ſhould be put into one glaſs than is ſufficient to cover its bottom: The veſſel ſhould be placed in ſand, in ſome furnace where a conſtant heat is to be kept up, and the ſand raiſed round the glaſs a very little higher than the ſurface of the Mercury within: The degree of heat is one of the principal points; if too ſtrong, the Mercury will be diſſipated, and if too weak, it will not undergo the intended change: It ſhould be gentle at firſt, and increaſed with caution. When a quantity of calx or red powder has thus once been obtained, the admixture of this with freſh Mercury remarkably promotes its calcination. From this circumſtance the philoſophers by fire have been led into many different ſpeculations, which in general have but little foundation. The change which the Mercury undergoes is not near ſo great as they have imagined: On a bare increaſe of the heat, it puts off its diſguiſe,

and reſumes its original running form. Mercury may be changed into powder by bare agitation in a cloſe veſſel: This powder differs from that obtained by fire in being of a grey or black colour. See page 91. MERCURY.

Sundry mercurial waters, and oils as they are called, are employed by the ſurgeons, almoſt every one having a preparation of this kind of his own. They are all only diluted ſolutions of Mercury; having for their baſis either ſolution of corroſive Sublimate, or a ſolution of Quickſilver in Aqua fortis. A dram of Sublimate, diſſolved in a pint of Plantane water, makes the *aqua divina* of Fernelius. Mercurial waters.

Amalgamation, or the ſolution of metals in Mercury, is ranked as one of the chemical operations: In ſome caſes it ſeems to depend as much upon the Mercury being divided by the metalline powder, as on its power of diſſolving the metal as a menſtruum. For obtaining an amalgam or a kind of paſte of Quickſilver and metals, the metal ſhould previouſly be reduced into ſmall parts, either by mechanic operations, as granulation, filing, *&c.* or by ſolution in acids and precipitation: The precipitation ſhould be made, not with Salts, for the calces thrown down by Salts will not unite with Mercury; but with ſome other metal: Thus Silver is to be precipitated by Copper, Copper by Iron, *&c.* Heat promotes amalgamation: By its aſſiſtance we may obtain amalgams of ſome metallic bodies that cannot be amalgamated without it. See page 65. Amalgamation.

Much has been talked of ſolid or coagulated Mercury; but all the preparations of this kind, if they have any Mercury in them, are no other than hard amalgams. When melted Lead or Tin are juſt becoming conſiſtent, a ſtick is thruſt into the metal, and the hole filled with Quickſilver: By the time the whole is grown cold, the Mercury is found ſolid and crumbly, the heat having promoted the union of the metal with it. Maurice Hoffman, in the acts of the Altdorff elaboratory, gives a proceſs for reducing the Mercury ſo coagulated to a ſtate of malleability, by repeatedly melting and quenching it in Linſeed-oil: A malleable metal is thus really obtained, which may be formed, as he promiſes, into rings; but it is not Mercury: All the Mercury is diſſipated in the fuſions, and nothing is left but the Lead or Tin. Still more ridiculous are thoſe, who melting an amalgam of Copper along with Tutty, imagine the Braſs that reſults to be a production of the Mercury. Coagulated Mercury.

A diaphoretic fixt Mercury has been a grand object of purſuit among the chemiſts. I have met with many pretenders to ſuch an arcanum, but have never yet found any truth in their pretences; ignorance of the principles of genuine chemiſtry, and of the properties of the bodies which they worked upon, having led them to believe, that when they had loſt their Mercury, they had fixed it. One made his fixt Mercury, by diſſolving two ounces of Quickſilver in Aqua fortis, adding by degrees one ounce of Regulus of Antimony, and then mixing a quantity of brine of Sea-ſalt: The matter being now exſiccated, he proceeded to the fixation, that is the diſſipation, of the Mercury, by deflagrating the mixture with Nitre.

But the moſt extraordinary of all the preparations, which the alchemiſts have pretended to make from Mercury, is the alkaheſt or univerſal menſtruum. Kunckel has ſhewn the abſurdity of ſuppoſing them poſſeſſed of ſuch a menſtruum. Alkaheſt.

MERCURY. menſtruum, by a ſimple queſtion, "If it will diſſolve every thing, what "veſſel can it be kept in?"

Mineral hiſtory. Quickſilver is found in the earth, ſometimes in its running form, but much more commonly in that of an ore. The native running Mercury, called Virgin, has been preferred by ſome to that which is extracted from the ore and purified by art; but no experiment affords any foundation for ſuch a preference. The ores are of three kinds, (1) fine red ones, called native Cinnabar, differing from the factitious Cinnabar only in having ſome earthy, ſtony, or other heterogeneous matters intermixed, (2) ſtony ores, and (3) clayie or loamy earths. The two laſt ſorts are much poorer in Mercury than the firſt: They contain more Sulphur than is requiſite for forming a red cinnabarine compound, and appear commonly of a blackiſh or greyiſh-black colour, without ſo much as a ſpeck or a vein of red.

Mines of Quickſilver are extremely rare (o). The only conſiderable ones known are in ſome parts of the imperial hereditary dominions, and in Spain; particularly at Friuli and Iſtria in Carinthia; and at Almaden de la Sierra Morena in the province of Eſtremadura. The ores in the imperial dominions are chiefly of the cinnabarine kind; the Spaniſh, poorer and more earthy: Spain however produces as much Quickſilver as Friuli, or rather more. At Almaden, in the year 1717, there were twenty-five thouſand quintals or Spaniſh hundred weights of Quickſilver, which amount to above three millions of pounds of our weight: From thence are ſent yearly to Mexico, fleets laden with Quickſilver, for the amalgamation and extraction of Gold and Silver from the rich minerals of that country: The exportation either of Mercury or Cinnabar to other places, is prohibited. The mines of Friuli have been obſerved to afford 695,334 pounds of Quickſilver in three years: All the imperial Quickſilver is brought to Holland, the Dutch having entered into a contract with the Emperor for that purpoſe.

It may be proper to obſerve, that Mercury is never found in the mines of any other metals; nor any other metals in the mines of Mercury; except that ſometimes a mineral containing a little Gold or Silver ſhall be met with among mercurial ores, and even this is an exceeding great rarity. This obſervation ſeems to ſufficiently refute the opinion of thoſe who hold Mercury to be an hypoſtatic principle or ingredient in all metals: For if metals were, and continued to be, produced from Mercury, we certainly ſhould, ſometimes at leaſt, diſcover one where the other is.

Lemery, Pomet and others lay down ſome external marks, for diſtinguiſhing thoſe places in which there are mines of Quickſilver; namely, thick vapours, like clouds, ariſing in the months of April and May; the plants being much larger and greener than in other places; the trees ſeldom bearing flowers or fruit, and more ſlowly putting forth their leaves. But theſe marks are far from

(o) *Mines of Quickſilver rare.*] According to Hoffman's computation, the annual produce of Gold from mines is fifty times greater than that of Quickſilver. Cramer ſuſpects he means only five times; and that Quickſilver occurs in the earth more frequently than we are aware of; this volatile ſemimetal being diſſipated in the common proceſſes by which ores are worked or aſſayed.

from being certain: They are not obſerved in all places where there is Quick-ſilver, and they are obſerved where there is none. In the Hartz-foreſt we ſee abundance of thoſe cloudy exhalations, though not a grain of Mercury is found there. MERCURY.

The method of extracting Quickſilver from its ores differs according to the ſubſtances naturally joined to it. For the imperial cinnabarine ores, certain additions are employed, to abſorb their Sulphur, as filings of Iron: Or the ore is diſtilled *per deſcenſum* in perforated iron pots. The Spaniſh ores require no addition, nor any iron veſſels, theſe naturally containing a calcareous earth ſufficient to imbibe the Sulphur: The ore being thrown in at one end of a furnace, the Mercury is extricated in fume from all its natural admixtures, and after paſſing through a number of horizontal aludels, condenſes in a reſervoir at the further extremity. In ſome places the more impure ſtony ores are ſtamped, and the lighter matters waſhed off from them; after which, the more ponderous and pure part is diſtilled either by itſelf or with additions according to its quality. An account of the Spaniſh Quickſilver furnaces may be ſeen in the French Memoirs for the year 1719. Extraction from its ores.

The finer coloured cinnabarine ores are never worked for Mercury, but employed as Cinnabar; and have by many been injudiciouſly preferred to the more pure factitious Cinnabar. We ſeldom meet with any native Cinnabar that has not a viſible admixture of earthy or ſtony matter, nor with two pieces that perfectly agree. CINNABAR. Its natural hiſtory.

Maſſes of native Cinnabar are found in Hungary, Tranſylvania, Carinthia, Bohemia, the Palatinate, France, Spain, ſometimes in Sweden, and as is ſaid in the Eaſt-Indies, particularly Japan, but greateſt part of what is ſold under the name of Japan Cinnabar, is manufactured in Holland. In the ſhops, three principal ſorts are diſtinguiſhed, (1.) Cinnabar in maſſes, ſome of which weigh one, two, ſix ounces, and more. (2.) Cinnabar in grains, prepared by breaking the coarſer maſſes, and picking out the bits of Cinnabar from the ſtony matter intermixed, (3.) waſhed Cinnabar, prepared from ſuch maſſes as are ſtill fouler, by reducing them to powder, and waſhing off their lighter impurities. The firſt ſort is accounted the beſt, and the laſt the worſt. Many have been particularly fond of the Hungarian Cinnabar, ſuppoſing it to be impregnated with Gold, becauſe in Hungary there are mines of Gold: So far has this ridiculous conceit prevailed, that not only the minerals, the Cinnabar, the Antimony, the Copper, the Vitriol, but the very vine-trees of Hungary, have been imagined to participate of that metal.

Native Cinnabar ſhould never be employed for any medicinal uſe without purification; and the only method of purifying it effectually is ſublimation; the ablution, by ſome directed, being by no means ſufficient. I have never met with any that did not leave on ſublimation a grey aſh or ſand, amounting, in different parcels, to one ninth, one eighth, one ſeventh, one ſixth, and one fifth of the Cinnabar employed. Sixteen ounces of waſhed Cinnabar left above two ounces of fixt matter: Of the part which ſublimed, only about ten ounces were pure compact Cinnabar, the reſt being ſpongy, and not ſo clean: By repetitions of the ſublimation, the whole became purer and finer coloured. The Chemical examination.

CINNABAR. residuum imparted to Aqua regia a yellow colour like that of a solution of Gold; and Spirit of Sal ammoniac precipitated from this tincture a calx which looked like Aurum fulminans: It did not however fulminate, nor give any other marks of Gold than its colour. What particular substance this soluble part of the residuum was, I did not examine; but it certainly was not Gold, for Aqua fortis dissolved it as well as Aqua regia.

Some add a little calcareous earth in the sublimation of Cinnabar; to absorb a portion of its Sulphur, and thus improve its colour: It is an over-proportion of Sulphur that makes the colour blackish, and not, as some have pretended, too strong a fire; for strong fire does no injury to Cinnabar.

The proportions of Mercury and Sulphur are different in different Cinnabars: The ordinary sorts, purified by sublimation, contain commonly four parts of Mercury to one of Sulphur: The finer have more Mercury. It is observable, that though Oil of Vitriol forms with Mercury a lively yellow concrete, Turpeth mineral; and with the inflammable principle, a yellow Sulphur; and though this Sulphur forms with Mercury a beautiful red Cinnabar; yet Oil of Vitriol totally destroys this red colour, changing the Cinnabar white as milk.

II. BISMUTH.

BISMUTH. BISMUTH, or Tin-glass, is a sparkling white semimetal, very ponderous, considerably hard and sonorous, extremely brittle, without any degree of malleability, falling in pieces under the hammer, and reducible by triture into fine powder. When broke, the surface of the fracture appears composed of bright plates or flakes, larger than those of the other semimetals. In its external appearance, it has a great resemblance to Regulus of Antimony and Zinc, differing little otherwise than in the largeness of the plates, and in its contracting a yellowish cast on the surface exposed to the air. In its intrinsic properties, it is extremely different; melting far more easily, not evaporating so readily, being differently acted upon by acids, producing different effects upon other metallic bodies, *&c.*

Its general properties,

examined by fire, Bismuth melts in the fire long before it grows red-hot, considerably sooner even than Lead. Kept in fusion and stirred, it soon calcines; gaining at the same time an increase in its weight, of near half an ounce upon a pound. The calx melts, upon raising the fire a little, into a browniſh or yellowish glass; which promotes the vitrification of earths and the refractory metallic calces more powerfully, and corrodes and sinks through the common crucibles more readily, than glass of Lead itself. If Bismuth be mixed with Gold or Silver, a heat that is but just sufficient to melt the mixture, will presently vitrify a part of the Bismuth, which then having no action on those perfect metals, separates and glazes the crucible all round (*p*).

Calx

(*p*) *Bismuth.*] This semimetal approaches in specific gravity to Silver, being nearly ten times heavier than an equal bulk of water. It melts a little later than tin, and seems to flow the thinnest of all metallic substances. When in fusion, it occupies less volume than in its solid state; a property peculiar to Iron among the metals, and Bismuth among

Calx of Biſmuth, long reverberated, does not, as ſome pretend, become red like the calces of Lead. It ſcarcely retains even the form of a calx, a part of the Biſmuth being revived into its metallic appearance by the flame: None of the deſtructible metallic bodies is ſo eaſy of revival as this ſemimetal. If the veſſel is covered, and all inflammable matters excluded, vitrification is the only change that enſues. BISMUTH.

The nitrous acid diſſolves Biſmuth with great efferveſcence, and a copious diſcharge of yellow corroſive fumes. The ſolution, if the Biſmuth has not been too haſtily added to the acid, proves colourleſs and tranſparent (*q*): Diluted with a large quantity of water, it becomes milky, and depoſites on ſtanding a fine white Precipitate or Magiſtery; which edulcorated by repeated affuſions of water, is employed as a coſmetic, both in waſhes and pomatums, under the name of Spaniſh or pearl white. by the nitrous acid,

There are ſundry variations in preparing this Magiſtery. Some take Aqua regia for the menſtruum; and for the precipitant, a ſolution of Sea-ſalt, alcalies, Spirit of Wine, *&c.* Some mix with the ſolution of Biſmuth, a ſolution of Benzoine in Spirit of Wine, and thus obtain a Magiſtery compoſed of calx of Biſmuth and Benzoine. Others add a ſolution of Chalk to the metalline ſolution, and precipitate both together with alcalies. I have made trial with a good number of different precipitants, and found, that with common fixt Alcali and cauſtic Alcali, with watery and vinous alcaline ſpirits, the Magiſtery was white, and in conſiderable quantity; the liquor after the precipitation with volatile ſpirits, appearing blue: That Oil of Vitriol threw down a white Precipitate very copiouſly; but that with Spirit of Vitriol, Spirit of Salt, and weak Spirit of Nitre, the Precipitate was in very ſmall quantity, in colour white like the foregoing; and that diſtilled Vinegar made no precipitation at all: That common rectified Spirit of Wine and tartarized Spirit, common water and Lime-water, gave white Precipitates: That ſolutions of Nitre, vitriolated Tartar, Sal mirabile, Alum, Borax, common Salt (*r*), Sal ammoniac, the combination of calcareous earth with marine acid called fixed Sal ammoniac, and the terra foliata Tartari, all Magiſtery of Biſmuth,

among the ſemimetals. It emits fumes in the fire ſo long as it preſerves its metallic form: When calcined or vitrified, it proves perfectly fixed.

(*q*) *Nitrous acid.*] Proof Aqua fortis diſſolves about half its weight of Biſmuth: If the ſolution is haſtily performed, the liquor appears greeniſh. A part of the Biſmuth cryſtallizes almoſt as faſt as it diſſolves, or at leaſt as ſoon as the heat ariſing from the action of the acid ceaſes, unleſs the menſtruum is diluted with about an equal quantity of water——Both fixt and volatile alcalies totally precipitate it. Volatile alcalies, added in larger quantity than is ſufficient for that effect, take it up again: The liquor generally appears greeniſh; by alternate additions of the alcaline ſpirit and of the ſolution, it becomes bluiſh or purple. Fixed alcalies, calcined with inflammable matter, likewiſe rediſſolve the Biſmuth after they have precipitated it.

(*r*) *Precipitate by Sea-ſalt.*] It has been commonly ſuppoſed that Sea-ſalt or its acid carry down Biſmuth from its ſolution in the nitrous acid, in the ſame manner as it does Silver, Lead, and Mercury. A ſolution of Sea-ſalt will indeed precipitate all the four, but with this difference, that the precipitates of the three latter are found intimately combined with the acid of that Salt; whilſt the Precipitate of Biſmuth retains nothing of it, and was thrown down, not by the ſaline, but by the aqueous part of the liquor. Simple water precipitates it, but Sea-ſalt undiſſolved, or a ſolution of it added in ſmall quantity, does not.

BISMUTH. all precipitated the Biſmuth white: That with a ſolution of Gold in common Aqua regia, the Magiſtery proved grey; with a ſolution of the ſame metal in an Aqua regia made with Spirit of Salt, it was likewiſe grey, but in much leſs quantity; with ſolution of Copper in Aqua fortis, white, and in very ſmall quantity, the liquor continuing blue; with ſolution of Vitriol of Copper, white; with ſolution of Mercury ſublimate, white and plentiful; with ſolution of Iron in Aqua fortis, yellowiſh; with ſolution of Lead in Aqua fortis, and of Sugar of Lead, white; with ſolution of Zinc in Aqua fortis there was little Precipitate; and with ſolutions of Silver, of Tin, of Regulus of Antimony, and of Mercury, in the ſame acid, none at all. On boiling ſome powdered Biſmuth in a ſolution of green Vitriol, the liquor did not grow turbid, as it would have done by itſelf, but rather clearer and clearer: A fixt alcaline Lixivium being afterwards added, it turned white and thick, but on ſtanding for ſome time depoſited a greeniſh matter, which on drying changed to a light brown: A little of the liquor evaporated and ſet to ſhoot, yielded cryſtals, which in appearance and taſte reſembled Vitriol of Iron.

Some prepare the Magiſtery of Biſmuth, by ſubliming the powdered Biſmuth with Sal ammoniac, diſſolving the flowers in diſtilled water, and then precipitating with volatile or fixt Alcali: Others add Nitre in the ſublimation, but this addition rather injures than improves the colour of the product: And indeed the Sublimates obtained by either method are leſs fit for making the Magiſtery than Biſmuth in ſubſtance, for the ſolution of them, whatever care is taken in the operation, will not be limpid, but green. Some, inſtead of the Magiſtery, direct a calx to be made by deflagrating the Biſmuth with Nitre, expecting that the Biſmuth will detonate like Antimony, and that the calx will reſemble that of Antimony prepared in the ſame manner: Others direct the flowers which ariſe during the deflagration, to be caught in aludels for the ſame purpoſes. But Biſmuth, though it is very readily calcined by Nitre, does not ſenſibly deflagrate with it: The flowers and the calx are not perfectly white, but yellowiſh; and the quantity of the flowers is ſmall, only two ounces having been obtained from ſixteen.

The Magiſtery of Biſmuth appears to have ſome latent corroſive quality; and when freely uſed as a fucus, not to be entirely innocent: It gradually impairs the natural complexion; and leaves, for old age, a coarſe and diſagreeable ſkin. The peruke-makers are ſaid to employ it in their pomatums for giving a whiteneſs to grey, reddiſh, yellow, or other coloured hair; and Pomet obſerves that a ſhower of rain will waſh off this adventitious whiteneſs. I have been informed alſo, that thoſe who bleach hair in England make uſe of this Magiſtery; and therefore I determined to examine by experiment its effects upon hair. Experiment ſatisfied me that the report was groundleſs; that the Magiſtery of Biſmuth does not whiten hair but darken it; that it changes the whiteſt flaxen hair firſt to a yellowiſh, then to a yellowiſh-brown, afterwards to a dark brown, and at laſt to a black. The trial may be made in two ways; by boiling the hair in water along with the Magiſtery; or by applying the Magiſtery mixed with Pomatum, and hanging the hair in the ſun: The oftener this is repeated, the darker will the colour be. We may judge from hence, that this Magiſtery is leſs fit for the purpoſes of a coſmetic, than

than it is generally ſuppoſed to be. The Magiſtery itſelf has been commonly believed to change its colour in the ſun, and hence it is directed to be dried cautiouſly in a ſhady place; but it did not appear to have ſuffered any conſiderable alteration on being expoſed to the ſun for two months. It is apt, however, in length of time, to turn yellowiſh; and hence a large ſtock ſhould not be prepared at once.

Spirit of Sea-ſalt, though long boiled with Biſmuth, diſſolves very little; and Aqua regia not much. The effect of the concentrated marine acid in Mercury ſublimate I was induced to try, from Mr. Boyle's account of a pearl-like ſublimate obtained from Biſmuth and that mercurial preparation. One part of Biſmuth in fine powder and two of corroſive Sublimate, mixed together and expoſed to the fire in a retort, immediately melted into a blackiſh brown pitch-like maſs: A portion of Quickſilver diſtilled, and was followed by a dark brown butter, which on cooling grew hard as a ſtone: In the retort, a little melted Biſmuth remained. On rectifying the butter a ſecond and third time ſome more running Mercury ſeparated, the butter became clearer and browner, and at the ſame time harder. On a fourth rectification, I had two kinds of butter, a white and a brown. The white being rectified twice by itſelf, an unctuous pearl-coloured matter remained each time, and the butter became ſtill whiter. The brown was then mixed with the white, and the rectification again repeated ſix times: A like pearl-coloured ſubſtance was left in every diſtillation, the quantity of butter grew leſs and leſs, and at length there was none to be ſeen. So that by this troubleſome operation I obtained the product intended by the author, though it was not properly a Sublimate, having remained in the retort after ſublimation.

treated with marine acid.

Pearl-coloured powder,

Oil of Vitriol diſſolves Biſmuth into a roſe-coloured liquor (*s*), which on ſtanding turns browniſh; but Spirit of Vitriol has little effect. If a ſolution of Biſmuth in Aqua fortis be evaporated to one half, ſome Quickſilver and Oil of Vitriol added, the evaporation continued to dryneſs, and the dry matter ſet to ſublime; there ariſes firſt a little Quickſilver, and afterwards a perfectly white mealy Sublimate: In the bottom of the retort remains a greeniſh matter variegated, if the heat has been ſtrong, with rainbow colours. Diſtilled Vinegar diſſolves a little by ſtrong coction, and acquires from it, not, as ſome pretend, a ſweet taſte like that of ſaturnine ſolutions, but a conſiderably acerb and ſtyptic one.

with Oil of Vitriol,

Biſmuth cemented with Sulphur, readily unites with it, and melts eaſier than by itſelf; but on continuing the fire, they ſoon ſeparate again, the Biſmuth falling to the bottom, and a ſulphureous ſcoria ſwimming on the ſurface. Calx of Biſmuth likewiſe very eaſily abſorbs Sulphur, and forms with it a curious needled maſs, exactly reſembling Antimony, contracting a reddiſh tinge externally on expoſure to the air: The quantity of Sulphur imbibed is leſs than half the weight of the calx; a part of the Sulphur having ſublimed when the operation

with Sulphur,

(*s*) *Oil of Vitriol with Biſmuth.*] The vitriolic acid in ſome degree corrodes this ſemimetal, but does not perfectly diſſolve it, however concentrated or aſſiſted by heat. The roſe-coloured ſolution, mentioned by the author, was probably obtained, not from Biſmuth itſelf, but from Biſmuth ore; the ore participating of a metallic ſubſtance of a different kind, which gives a reddiſh colour to all acids.

BISMUTH. operation was performed, in a retort, with that proportion. Silver, added to this antimoniated concrete, melts with it, in a very gentle heat, into a brittle Regulus: Gold alſo unites with it, but requires a much ſtronger fire; the compound is brittle, in appearance like an ore, with here and there ſome ſtriæ or ſhining particles. Copper melts with it, in a ſmall heat, with remarkable facility; and after they have been united, the compound continues to retain this extraordinary fuſibility: On the addition of Lead, a new combination happened: the Copper and Sulphur aroſe to the ſurface in ſcoria reſembling an ore, whilſt the Biſmuth and Lead formed a Regulus at the bottom.

with different metals, With regard to the effects of Biſmuth upon metals (*t*), (1.) Equal parts of Biſmuth and Gold, melted together, formed a quite brittle Regulus, which had ſcarcely any yellowiſh hue, and looked almoſt like Biſmuth itſelf; as ſoon as they began to melt, a vitreous matter appeared round the crucible. (2.) Equal parts of Biſmuth and Silver formed a white compound, leſs brittle than that with the Gold: It bore the hammer a little, and ſeemed at firſt as if it was going to extend, but at laſt it cracked. The ſame ſudden vitrification was obſerved, as in the foregoing experiment. (3.) With Tin, it melts exceeding eaſily: The mixture at firſt frequently emits ſmall flames, and a part calcines: When the quantity of each was half an ounce, the loſs was five grains. If the fire is raiſed, the compound quickly calcines, like a mixture of Lead and Tin, into a yellowiſh white aſh. A ſmall portion of Biſmuth improves the brightneſs, hardneſs and ſonorouſneſs of Tin. (4.) Copper is ſaid to be changed of a Silver colour by Biſmuth; and hence the ſemimetal has been named *marcaſita argentea*; as Zinc, from its making Copper yellow, is called *marcaſita aurea*. In my experiments, there was no appearance of a Silver colour, except that when the Biſmuth was in very large proportion, its whiteneſs prevailed above the redneſs of the Copper. Copper mixed with an equal weight of Biſmuth had its red colour only diluted or rendered paler, and its malleability deſtroyed: A part was changed in the fuſion, into a dark red ſcoria, amounting to a dram upon half an ounce of each of the ingredients. (5.) Equal parts of Biſmuth and Lead yielded a dark grey compound, which bore to be bent a little without breaking: The loſs in fuſion was two ſcruples upon half an ounce of each of the metals. (6.) Iron and Biſmuth, in the ſame proportions, emitted flames in the fire, and in a ſtrong heat united together. (7.) The ſame quantities of Regulus of Antimony and Biſmuth melted perfectly together, and loſt only fifteen grains: The mixt looked like Regulus of Antimony by itſelf. (8.) Zinc and Biſmuth did not unite at all, the Zinc flowing diſtinct upon the ſurface, and burning as it does by itſelf. (9.) Mercury forms with Biſmuth an

(*t*) *Biſmuth with metals.*] Biſmuth does not mingle in fuſion with Regulus of Cobalt or Zinc: The addition of Nickel or Regulus of Antimony, renders it miſcible with the former, but not with the latter. It unites with all the others, and greatly promotes both the tenuity and facility of their fuſion. It whitens Copper and Gold, and improves the whiteneſs of ſome of the white metals: Mixed in conſiderable quantity, it renders them all brittle, and of a ſtructure, like its own, flaky or plated. Though it poſſeſſes ſeveral properties of Lead, and in certain circumſtances remarkably ſubtilizes that metal, yet in mixture they agree but ill together: On expoſing compoſitions of them to a moderate fire, a colluctation enſues, and both metals fall quickly into a calx, like a mixture of Lead and Tin.

an amalgam, which readily adheres to Iron: If the Iron, coated with the amalgam, be expoſed to the fire, the Mercury exhales, and greateſt part of the Biſmuth remains fixt upon the Iron, which now looks as if it had been ſilvered. If mixtures of Biſmuth with ſome other metals, particularly Lead, be amalgamated, the Lead is found to be ſo attenuated, as to paſs with the Quickſilver through leather: On ſtanding, the Biſmuth is thrown up to the ſurface in form of a dark coloured powder, the Lead remaining diſſolved in the Quickſilver. (10.) Equal parts of Lead, Copper and Biſmuth, yielded a Regulus of a ſooty black colour on the upper ſurface: The loſs in fuſion was one dram upon three half ounces of the mixture. (11.) Equal parts of Lead, Tin and Biſmuth, formed a blackiſh ſparkling compound, reſembling the ſmall-diced ores of Lead. (12.) It is obſervable, that the ſpecific gravity of a mixture of Biſmuth and Copper is exactly the mean gravity of that of the two ingredients unmixed; but that mixtures with Iron are ſpecifically lighter than the ingredients ſeparately; and mixtures with Gold, Silver, Tin, Lead, and Regulus of Antimony, heavier. BISMUTH.

Biſmuth is applied to various uſes in the chemical arts, as (1.) For making Pewter with Tin; this metal being of itſelf too ſoft for the common purpoſes of utenſils, and never being worked without ſome additional metallic matters, of which Biſmuth is one of the principal. (2.) For ſoldering Lead and Tin; a mixture of Biſmuth with theſe metals being eaſier of fuſion than either of them ſeparately. The common ſolder is compoſed of two parts of Lead, two of Tin, and one of Biſmuth (*u*). (3.) As an ingredient in the compound metal for Printers types. Types indeed are often made, without any Biſmuth, from a mixture of one part of Copper, one of Antimony, and five of Lead; but Homberg, a celebrated German chemiſt who ended his days in Paris, has obſerved, that the addition of Biſmuth and Tin greatly improves the compoſition: He adviſes equal parts of theſe to be melted together, and one part of this maſs to be melted with ſix of the ordinary mixture. (4.) In foils for mirrours; the common mixture for theſe purpoſes conſiſts of one part of Tin, one of Lead, two of Biſmuth, and ten of Quickſilver, amalgamated together. Uſes.

A

(*u*) *Fuſibility of mixtures of Biſmuth, Tin and Lead.*] The degree of heat, in which theſe metals by themſelves, and certain mixtures of them, melt or, when melted, begin to ſet or grow ſolid again, has been examined by thermometers. The following table exhibits nearly their proportional fuſibility, compared to the heat of boiling water and Quickſilver, according to Fahrenheit's ſcale.

600. Quickſilver boils.
540. *Lead melts.*
460. *Biſmuth melts.*
410. *Tin melts.*
390. *Tin* 8. *Biſmuth* 1. *melt.*
330. *Tin* 2. *Biſmuth* 1. *melt.*
Tin 3. *Lead* 2. *melt.*
280. *Equal parts of Tin and Biſmuth, melt.*
212. Water boils.

In theſe kinds of experiments, and indeed in all caſes where the heat is continually increaſing or decreaſing, we cannot expect any great degree of preciſion; for as the thermometer receives only ſucceſſively the heat which acts upon it, it cannot expreſs the exact heat of the body applied at any particular inſtant of time. Whilſt the inſtrument expreſſes one degree of heat, the ſurrounding matter may have acquired a conſiderably greater or ſmaller; and by the time that the thermometer has riſen or fallen to that degree, the heat of the matter may be again varied.

BISMUTH. balls may be seen in Boyle's treatise of the usefulness of experimental philosophy. (5.) In mixtures for anatomical injections, particularly of the lungs: Some take equal parts of Bismuth, Lead, and Tin; others add a little Quicksilver. (6.) For imitating Silver on wood. The turners grind Bismuth into a subtile powder, and temper it with whites of eggs: This applied on wood, looks, when dry, of an ash colour; but on being burnished with a tooth, it assumes the appearance of dusky Silver. (7.) For imitating Silver upon Iron, as mentioned in the ninth experiment of the preceding paragraph. (8.) For purifying Gold and Silver by cupellation, scorification, *&c.* For these purposes it is preferable to Lead, as it more effectually promotes the destruction of the imperfect metals, and the vitrification of earths and calces (*x*). It has one great advantage above Lead in all operations of this kind where Sulphur makes one of the ingredients; namely, its forming with that concrete an extremely fusible mass, whilst Lead combined with Sulphur proves extremely refractory.

Abuses, Bismuth has been too often employed for the adulteration of Quicksilver, as rendering a very considerable proportion of Lead intimately miscible with it: Becher was acquainted with means of combining no less than one dram of Lead and the same quantity of Bismuth with three drams of running Mercury. Quicksilver so adulterated, is not only unfit for medicinal use, but for the common mechanic purposes of gilding and silvering: The workmen observe, that it leaves upon the Gold or Silver a livid leaden hue. The abuse is discovered, and the Mercury purified, by distillation. Some of the Wine-coopers have mixed Bismuth with Sulphur, for the fumigation of casks; but as no good reason is alledged for this use of it, and as it may be productive of ill effects, it ought surely to be rejected. See Wepfer *de compositione noxia sulphuratorum cum Bismutho*; Camerarius's *sylloge memorabilium medicinæ, cent.* 8. N° 23. and a paper by Dr. Salomon Reisel in the *Ephem. nat. curios. dec.* 3. *ann.* 5 *&* 6. Though Bismuth, however, when thus corroded by the sulphureous acid, and dissolved in Wine, may produce dangerous effects; it does not follow that the Bismuth in Pewter dishes will communicate any ill quality to Vinegar or the other acids used in food; distilled Vinegar extracting nothing from Bismuth without strong coction.

Medical effects. This semimetal has been held by some in considerable esteem as a medicine. The Magistery, the Calx, the Flowers, and sundry other preparations of it, have been said to be diaphoretic; to be serviceable in virulent gonorrhæas, gouty complaints, and contractions of the limbs. But experience affords little foun-

(*x*) *Use of Bismuth in cupellation.*] Bismuth is particularly preferable to Lead for the cupellation of Gold or Silver blended with refractory matters; as it procures a greater tenuity of fusion than Lead is capable of doing. Monsr. du Fay observes, that Gold is sometimes met with very eager, pale, livid, and difficult of fusion, from an admixture, as he supposes, of Emery; and that it is most effectually purified by means of Bismuth. The method, which he communicated to the French Academy for its purification, consists in melting it with an equal quantity of Bismuth and pouring out the fluid part, adding more Bismuth to the remainder and proceeding in this manner till the whole runs out clean, and then working off the Bismuth upon a cupel; after which, the Gold is to be again cupelled with Lead; and lastly, some corrosive Sublimate to be injected upon it in fusion.

foundation for these virtues, nor even for supposing it to be safe. Some preparations of Bismuth have seemed to repress febrile heat; but extreme anxiety, and other ill consequences have ensued. BISMUTH.

Bismuth is extracted from its own proper ore, which is found most plentifully in Saxony, near Schneeberg, and of which some quantities are met with also in Bohemia, and in England. Many have affirmed that it is an artificial composition, and accordingly delivered processes for making it; of which processes I tried those, which seemed to approach the nearest to probability. Two ounces of Arsenic, one ounce of Verdegris, half an ounce of Sal gem, and half an ounce of oil Olive, were well ground together: Three ounces of English Tin, melted with this mixture, yielded a Regulus weighing four ounces and two drams, very brittle, of a grey colour, entirely different from Bismuth in appearance as well as quality. But from four ounces of English Tin, two ounces of white Arsenic, one ounce of white Tartar, and half an ounce of Nitre, cemented and melted together, I obtained a Regulus, weighing three ounces and three drams, so much resembling Bismuth, as to be easily mistaken for it by one who had not thoroughly examined the appearance of that semimetal. There are however some differences in the structure of the two, very obvious upon comparing them together, but which are rather to be seen than described. In their intrinsic properties, they are extremely different: Thus the counterfeit, dissolved in Aqua fortis, forms a bluish coagulum, whilst the solution of the natural Bismuth continues uniform and limpid; the counterfeit, calcined and mixed with Sulphur, exhibits nothing of that singular needled structure, which the natural assumes in the same circumstances. Since therefore it has been reported, that the Bismuth met with in the shops is an artificial production, and since experiment shews that it is capable of being imitated in its external form though not in its qualities, we ought to be upon our guard against such an imposition. Counterfeited

The ores of Bismuth are met with chiefly in the mines of Silver and of Cobalt. They are commonly of a sparkling appearance, of a yellowish colour, or intermixed with yellowish veins; often reddish; often variegated with different colours, as bluish, reddish, and yellowish; and sometimes quite black. The yellowish sorts are called golden or philosophic marcasites, and have been held in great request among the alchemists. By lying long in the open air, they yield beautiful red striated efflorescences, called by the miners Flowers of Cobalt or of Bismuth. Ores.

Bismuth ores are assayed for Bismuth by pulverizing, and melting them, in a close crucible, with thrice their weight of black flux; a little charcoal dust being spread upon the surface of the mixture. The Regulus obtained by this process is assayed for Silver, by calcining it with Nitre; which soon scorifies the Bismuth, whilst the Silver, if it contained any, remains unhurt at the bottom. Assay.

In the large way, the ore, beat into small pieces, is placed in a low furnace or oven, so contrived, that the flame of the wood may play upon the surface of the mineral. The Bismuth melts out, by a heat no greater than that in which pure Bismuth melts; and runs off into a cavity made for receiving it; from whence it is taken out, and cast, in moulds, into round cakes. Ercker has Smelting in large.

BISMUTH.

given a wooden cut of the manner of ſmelting Biſmuth ore; and from this is copied the copper-plate in Valentini's *muſæum muſæorum*. The matter remaining after the eliquation of the Biſmuth, called *Wiſſmuthgraupen*, Biſmuth-earth, or Caput Mortuum of Biſmuth, is employed for making a blue glaſs, in the ſame manner as calcined Cobalt (*y*).

Experiments on the ore.

Blue glaſs,

changeable coloured liquor.

The crude ore, melted with colourleſs glaſs, or a fuſible compoſition of Sand and alcaline Salt, tinges it blue, deeper or paler, according to the proportions: On melting it with an equal weight of Nitre, the maſs proved likewiſe blue, but deliquiated in the air: With four times its quantity of the *Sal ammoniacum fixum*, it formed only a brown concrete, which being boiled in water, almoſt all the ore ſeparated, the liquor acquiring a ſlight yellowiſh tinge. A tincture drawn from the ore with Aqua fortis, mixed with a ſaturated ſolution of Sea-ſalt and inſpiſſated, yields a reddiſh Salt, whoſe colouring matter diſſolves both in rectified Spirit of Wine and in water; a white earthy ſubſtance remaining undiſſolved. The red watery ſolution is the curious liquor, which has lately been kept a ſecret, under the name of the green ſympathetic Ink. It may ſeem an impropriety to give a red colour the name of green: But this liquor is truly green, and of a fine green, when heated, as well as red whilſt cold; and in that ſtate wherein it is viſible as an Ink, it is always green. If written with on white paper, the characters diſappear as ſoon as they are dry: If the paper is held to the fire, they become green and legible: On cooling, they diſappear again; and this repeatedly for any number of times (*z*).

(*y*) *Biſmuth ore—blue glaſs.*] The ores of Biſmuth frequently accompany Cobalt, and always participate of its colouring matter, as Cobalt almoſt always does of Biſmuth. Probably, as Cramer obſerves, the two ores differ from one another only in this, that one contains more Biſmuth than the other—The reſiduum of Biſmuth ore is ſaid to afford a glaſs of a finer colour than that of Cobalt; and hence Biſmuth has been held a mark of the goodneſs of Cobalt, and ſuppoſed to contribute to the beauty of the colour. This concluſion, however, appears to be too haſtily drawn: For moſt Cobalts ſeem to contain more Biſmuth, than Biſmuth ores do after eliquation. If the obſervation itſelf is well founded, it tends rather to prove, that Biſmuth is injurious to the colour; more eſpecially as this ſemimetal is itſelf eaſily convertible into a yellow glaſs, which ſhould ſeem more likely to debaſe than to improve the blue colour of the Cobalt glaſs. The author of *Henckelius redivivus* mentions a Cobalt mine in Joachimſthal, abounding with Biſmuth, but yielding a glaſs of no value. See Cobalt.

(*z*) *Sympathetic Ink.*] This property of the tinging matter of Biſmuth-ore was publiſhed at full length by a German lady in 1705. The compilers of the *encyclopedie* attribute the diſcovery to Mr. Hellot; though that gentleman himſelf acknowledges that he received the firſt hint of it from a German chemiſt no earlier than the year 1736. The experiment ſucceeds beſt, when the tincture drawn from the calcined ore with Aqua fortis is mixed with a ſolution of one fourth its weight of Sea-ſalt, the mixture evaporated almoſt to dryneſs, and the reſiduum diſſolved in water. Mr. Hellot has given a variety of experiments on this ſubject in the French Memoirs for the year 1737. He obſerves, that with Nitre or Borax inſtead of Sea-ſalt, the characters become roſe-coloured when warmed, and if Sea-ſalt is afterwards paſſed over them, blue; that with Alcali ſufficient to ſaturate the acid, they change purple and red from heat.

III. ZINC.

ZINC (*Zincum, Contrefait, Tutenag, Spiauter, Spelter*) is a white ſemimetal, inclining a little to bluiſh, eſpecially when compared with the whiter metallic bodies, Regulus of Antimony, Tin, or Silver. It is conſiderably hard and ſonorous, and leſs brittle than any of the other ſemimetals: Hammered gently and leiſurely, it extends a little, but by a few quick blows, or a ſmart one, it cracks or breaks. In ſpecific gravity, it comes the neareſt to Tin; which laſt is ſomewhat the heavieſt of the two (*a*). ZINC. General properties.

It begins to melt in a moderate red heat (*b*); and when in fuſion, burns and fulgurates, with a deep yellowiſh green flame, a conſiderable noiſe, and an arſenical ſmell: If the fluid metal is ſtirred, the deflagration continues ſtrong, till nearly the whole quantity is deprived of its metallic form and ſublimed into flowers, which concrete about the upper part of the veſſel into fine, ſoft, white filaments, like down or cobwebs (*c*). It is obſervable, that in a broad Iron ladle, Zinc in filings will not melt near ſo ſoon as the ſame quantity in one piece; whereas, when bodies are reduced into ſmall parts, they commonly melt the ſooneſt: The difference in this caſe probably ariſes from the filings expoſing a larger ſurface to the external air, and the communication of the heat being intercepted by the vacuities betwixt them: The filings ſtrewed upon burning coals, melt and deflagrate much ſooner than larger pieces. The face, viewed Examined by fire.

(*a*) *Zinc.*] This ſemimetal makes a crackling noiſe in bending, like that of Tin, but louder: Broke, it appears internally of a fiſſile plated texture, partly dull coloured, partly bright and ſparkling. Expoſed to the air, it contracts, in length of time, a kind of yellowiſh ruſt. It is ſomewhat ductile when cold, but when heated proves entirely brittle. Its ſpecific gravity is to that of water as $7\frac{1}{16}$ to 1.

(*b*) *In the fire.*] It begins to melt as ſoon as it grows red-hot; but does not flow thin, or burn, or ſublime, till the fire is raiſed to a white heat. Kept juſt in fuſion, it calcines, ſlowly, not only on the upper ſurface, but likewiſe round the ſides, and at the bottom of the crucible: If ſeveral pieces are juſt melted together, the maſs, when grown cold, may be broke into the ſame number, their union being prevented by a yellowiſh calx, with which each piece is all over covered. Malouin relates, in the French Memoirs for the year 1742, that a quantity of Zinc being melted ſix times, and the fuſion continued fifteen hours each time; it proved on every repetition harder, more brittle, leſs fuſible, and leſs calcinable; that after the two firſt fuſions, its colour was grey, after the third brown, and after the fourth black; that the fifth rendered it of a ſlate blue; and the ſixth of a clear violet.

(*c*) *Flowers.*] The flowers once ſublimed from this ſemimetal are no longer capable of being elevated by the ſtrongeſt fire. In a heat far greater than that in which they aroſe at firſt, they ſuffer no alteration: In a very vehement one, they melt according to Henckel (*Act. Nat. Cur. tom.* iv.) into a ſemi-opake green glaſs: Vitrified with Borax, they give a grey or browniſh glaſs—— From the ſingular texture of the flowers they have been called philoſophic Wool, Cotton, Silk, and Talc: From the ſtrong green flame with which they ſublime, they are ſuppoſed by ſome to be the ſubſtance veiled by the alchemiſts under the titles of the golden fleece guarded by fiery bulls, and the dry water extracted from the ſunbeams; and the ſemimetal itſelf to be the Sun, the Luciſer, the green Lion, and the Dragon that vomits fire.

ZINC. viewed by the flame of Zinc, looks like that of a dead corps: The flame of Phoſphorus, and of Spirit of Wine impregnated with Sea-ſalt, exhibit the ſame phœnomenon.

Flowers. The veſſels commonly made uſe of for ſubliming flowers of Zinc, are two crucibles; one placed in the fire, for containing the Zinc; the other inverted upon it, by way of cover: This laſt is every now and then taken off, and the Zinc ſtirred. Some perform the ſublimation in a wide necked glaſs retort; others in an earthen body, &c. I have made a great number of experiments for determining the moſt ſucceſsful method, and the moſt commodious apparatus: I have tried open and covered crucibles, earthen and glaſs retorts, gentle and ſtrong fires, large and ſmall quantities, with and without ſtirring, in ſhort all the different ways I could think of. In this examination it appeared, (1.) That Zinc does not begin to ſublime when it begins to melt, but may be kept a good while in fuſion without deflagration or diſſipation. (2.) That the ſublimation commences with the burning and noiſe. (3.) That by a ſtrong fire in an open crucible, a conſiderable quantity, commonly one fourth its weight, is totally diſſipated; but that by a gentler heat the loſs is much leſs. (4.) That glaſs retorts are entirely unfit for this purpoſe, as they are apt to crack from the heat neceſſary for keeping Zinc in fuſion, and as the ſublimation, if they happen to ſtand the fire, does not well ſucceed in them. (5.) That earthen retorts anſwer better; but that theſe alſo are liable to an inconvenience; a groſs Sublimate ariſes after the finer flowers, and in breaking the neck of the retort, we cannot avoid mingling the two together. (6.) That when two crucibles are uſed, the more ſubtile flowers, whoſe quantity is but ſmall, ariſe into the uppermoſt; the more ponderous remaining in the lower, adhering to its ſides, and filling the veſſel as it were with a ſubſtance like burnt Alum, which proves more and more compact and groſs from the top to the bottom. (7.) That the flowers already ſublimed, muſt, if we expect any more Sublimate, be from time to time taken away; Zinc requiring room, and the acceſs of freſh air, for its ſublimation. In ſtirring the Zinc, or removing the flowers, care muſt be had, that none of them fall down upon the melted Zinc; for if they do, they will never riſe again, but remain a fixt calx, covering the metal and preventing its ſublimation. The beſt method, upon the whole, appears to be this: A large crucible being placed in a wind-furnace on a piece of brick, and made moderately red-hot, but not too ſtrongly heated, the Zinc is to be thrown in, in pieces: The crucible may be covered till the Zinc begins to burn, but after this period it ſhould be kept open: When any conſiderable quantity of flowers is obſerved in the crucible, they are to be cautiouſly taken out with an iron ladle, and this continued till nothing more will ariſe, or till the whole quantity of the Zinc is burnt. By this method the produce of flowers is greateſt; greater even than the weight of the metal employed: From half an ounce I obtained half an ounce and fifteen grains.

Reduction of the flowers, I have made ſundry experiments for reducing the flowers of Zinc into Zinc again. I urged them in a crucible, with tallow; but they ſcarce changed their colour; I treated them with Pitch and with Wax, but obtained only a blackiſh grey powder. Two drams of the flowers were put into a coated earthen retort, with an ounce of powdered Charcoal, and a receiver containing ſome water

water closely luted to the retort: The fire was raised by degrees, and kept up strong for some hours, that there might be no deficiency in point of heat: But upon unluting the vessels, I found in the neck of the retort only a yellow and grey Sublimate, with a few sparkling metallic particles: The coal at the bottom weighed six drams and one scruple: A skin appeared upon the water in the receiver, and a little powdery matter subsided. The experiment was repeated, with the addition of some Beef-suet to the Charcoal, and without any water in the receiver; but this time I obtained only an empyreumatic Oil from the Suet. Sundry trials were made likewise with alcaline Salts and Borax; without success. At last, having melted one dram of the flowers with six drams of Borax, in a quick fire, injected pellets of powdered charcoal made up with fat, and quenched the crucible in water, I found on breaking the vessel, small granules of revived Zinc, with a blackish grey semivitreous scoria. It appears from the whole, that the reduction of these flowers, though difficult, is not impracticable: Probably more successful methods might be discovered, if the enquiry was of any particular utility or importance (*d*).

I have sometimes granulated Zinc, by pouring it, when melted, into a wooden box, well rubbed all over on the inside with Chalk, and strongly shaking it. But in all the experiments with Menstrua, I used filings. It seems as if part of the file was abraded by the Zinc, some of the particles being attracted by the Magnet; and this may possibly happen also in the filing of other metals, though not hitherto observed. Granulated Zinc is not touched by the Magnet.

Oil of Vitriol did not dissolve Zinc, though an ounce of the acid was taken to half a dram of the metal: After several days digestion, the filings were only corroded into a white calx. Spirit of Vitriol made a complete solution: Its action was accompanied with a considerable heat, and an inflammable vapour, like that which arises during the dissolution of Iron. At first, a grey and blackish, spongy, flaky matter separated and arose to the surface, and soon after fell to the bottom, but on standing for some days was taken up and dis-

treated with Oil of Vitriol.

ap-

(*d*) *Reduction of the flowers.*] From the difficulty of recovering Zinc from its flowers and calces, the chemists have been led to suppose either that they are irreducible, or that the phlogistic principle of Zinc is of a different kind from that of other metallic substances. A more careful examination has discovered, that such inflammable matters, as reduce other calces, reduce equally those of Zinc; and that the difficulty lies, not in reviving, but in preserving this volatile semimetal after its revival. All calces, those of Iron excepted, require a stronger fire for their reduction than that in which the metal itself melts; and a full melting heat is the greatest that Zinc can sustain: Hence, in the instant of its revival, it burns and calcines again if the air is admitted, and in close vessels escapes, at least in part, through their pores. On mixing flowers of Zinc with powdered Charcoal, and urging them with a strong fire in a crucible, a deflagration and fresh sublimation ensue; sufficient marks, that the Zinc has been reduced into its metallic form; for so long as it remains in the state of calx, neither of these effects can happen. If the vessel is so contrived, as to exclude the air, and at the same time allow the reviving semimetal to run off from the vehemence of the heat into a receiver kept cool, the Zinc will there concrete and be preserved in its perfect metalic state. It is still more effectually detained by the addition of certain metallic bodies, as Copper, and Iron; with which the Zinc, when thus applied, unites more readily and perfectly, than it can easily be made to do by other means.

ZINC. appeared in the liquor, nothing being left but a little yellowiſh duſt ſcarcely worth mentioning. The liquor is as limpid and colourleſs as the Spirit of Vitriol itſelf.

with nitrous acid, Spirit of Nitre or Aqua fortis has a ſtronger appetite for Zinc than any other acid, and than this acid has for any other metal. It acts with great violence, and heat, and a copious diſcharge of reddiſh-yellowiſh-brown vapours; and preſently diſſolves almoſt the whole of the Zinc into a colourleſs tranſparent liquor.

with marine acid, Spirit of Salt likewiſe attacks Zinc very readily; but does not act near ſo violently, or diſſolve it ſo expeditiouſly, as Spirit of Nitre. A little fine blackiſh ſubſtance appears during the diſſolution, nearly like that which ſeparates with Spirit of Vitriol: But this alſo is at length diſſolved, only an inconſiderable portion of duſty matter remaining. The liquor is almoſt colourleſs, or very ſlightly yellowiſh.

with Aqua regia, Aqua regia acts on Zinc pretty violently, and diſſolves it ſpeedily, leaving, as in the foregoing experiments, a very little powdery matter. This ſolution is of a citron yellow colour; in which reſpect it differs from all the others. When an Aqua regia made with Sal ammoniac was employed, ſome ſmall cryſtals of Zinc ſhot at the bottom.

with vegetable acids, Diſtilled Vinegar ſeems at firſt to have little action on this ſemimetal: But on digeſting an ounce of the acid with half a dram of the filings, half a ſcruple was at length taken up. The ſolution looked milky, and had a ſweetiſh taſte reſembling that of ſaturnine ſolutions: On filtration, it became clearer, and on ſtanding ſtill more ſo; a little powdery matter having been left upon the filter, and a little more gradually depoſited to the bottom of the liquor——Two drams of filings of Zinc being boiled in water with an ounce and a half of powdered Tartar; the liquor, paſſed through a filter, was found to have loſt its acidity, and acquired a metallic taſte; and the Zinc to have loſt a ſcruple of its weight.

with alcalies. Alcalies, both fixed and volatile, were digeſted with filings of Zinc for a fortnight, but neither of them ſeemed to have made any ſolution. The metal appeared however to be in ſome meaſure corroded; the ſuperficial part having loſt its metallic aſpect, and changed to a black colour. In the filings which had been digeſted with the volatile ſpirit, ſome fine white particles were intermixed among the black, as if they had been taken up and depoſited again by the liquor.

Flowers; with acids, The flowers of Zinc did not diſſolve in Oil of Vitriol, any more than the ſemimetal itſelf; but, like it, they diſſolved in Spirit of Vitriol, and in the other acids. To try whether they retained any of the inflammable principle, of which Zinc itſelf ſo plentifully partakes, I evaporated a ſolution of them in the nitrous acid to dryneſs, and made the dry matter red-hot. It did not burn or deflagrate; which any inflammable ſubſtance, treated in the ſame manner with the nitrous acid, would have done. Homberg however pretends to have obtained an actual Oil from them: He diſſolved ſome of the flowers in diſtilled Vinegar, by digeſting them in freſh parcels of the acid; and diſtilled the ſolutions in a glaſs retort: At firſt, a quantity of phlegm aroſe, then the ſuperfluous acid, and at laſt an empyreumatic Oil. This Oil, though diſtinguiſhed by

by the titles of *Oleum florum Zinci*, *Oleum minerale*, and *Oleum metallicum*, is obviously no other than a fetid tartareous Oil proceeding from the Vinegar. He endeavoured to evade this objection, by pretending to make the same kind of Oil by Spirit of Vitriol, without Vinegar; but the experiment has never succeeded (*e*).

Precipitations.

That Zinc precipitates Iron, Copper, and other metallic bodies from the nitrous acid, and consequently has a greater affinity with that acid than the other metals have, was observed by Stahl: That it precipitates Copper from the vitriolic acid, is also known: And that it precipitates Iron likewise from the vitriolic acid, is believed, though this particular still wants a further examination. I dissolved pure Vitriol of Iron in distilled water, and added to the filtered solution large pieces, smaller pieces, and filings of Zinc, in the proportion of a dram to an ounce of the Vitriol; digested the mixtures with a considerable heat; and at last kept them for a time actually boiling. Some Precipitate there was, but apparently no more, and no other, than what the Vitriol itself would have deposited on the same treatment: The filtered liquor still yielded greenish crystals: The Zinc looked blackish-grey on the surface, but retained its original weight, and dissolved in Aqua fortis into a colourless liquor, a mark that it retained none of the Iron. From the opinion of Zinc having a greater affinity with the vitriolic acid than Iron has, Glauber, Stahl, and others have affirmed that the acid may be distilled from Vitriol, by the addition of Zinc, with less heat, and in a shorter time, than without that addition: How far this assertion agrees with experiment will be considered under the article Vitriol. Some recommend Zinc to be employed also in the distillation of the other mineral acids; but if a pure acid is wanted, this addition is by no means advisable; part of the Zinc being apt to arise, when the heat is increased to any considerable degree. It has been said, that Spirit of Vitriol, and Spirit of Salt precipitate Zinc from its solution in Spirit of Nitre: On trial, Spirit of Salt occasioned no precipitation, and Spirit of Vitriol threw down only a little greyish matter, like that which separates during the dissolution of Zinc when the vitriolic acid is applied to it at first.

Treated with Sal ammoniac.

Equal parts of filings of Zinc and powdered Sal ammoniac, being mixed together, and urged with a gradual fire in a retort; at first arose, in a very gentle heat, an excessively penetrating volatile spirit, so strong as to strike a man down who should inadvertently receive its vapour freely into the nose: This came over in subtile vapours, and was followed by a volatile Spirit of Salt in thick white fumes: In an open fire, white flowers succeeded, and at length

(*e*) *Oil from Zinc with Vinegar.*] Mr. Hellot obtained an oil seemingly different from the foregoing; by digesting the ash-coloured matter which remained after the distillation, with the acidulous phlegm which came over, for eight or ten days; distilling the tincture to dryness; and repeating the extraction with the distilled liquor, till the quantity of dry extract thus obtained was considerable. This resin-like matter, distilled in a retort with a stronger fire, yielded a yellowish liquor and a white Sublimate: The liquor discovered no mark of oil, but on being passed upon the Sublimate, immediately dissolved it, and then exhibited on the surface several drops of a reddish oil. Some of this oil was taken up on the point of a pencil, and applied on gold and silver-leaf: In twenty-four hours, the parts touched appeared, in both, equally dissolved.

ZINC. length a reddiſh and a black Butter. In the bottom of the retort was found a portion of the Zinc in its metallic form, with a little ponderous and fixt butyraceous matter, which liquefied in the air: The lump was far more brittle than Zinc ordinarily is, of a reddiſh colour on the outſide, and blackiſh within: The bottom of the retort was variegated with yellow and red colours, and looked extremely beautiful. The remaining Zinc was mixed afreſh with equal its weight of Sal ammoniac, and the proceſs repeated: A volatile alcaline ſpirit and marine acid were obtained as at firſt, and in the retort was found only a little black matter. When the Zinc was taken at firſt in twice the quantity of the Sal ammoniac, the part that preſerved its metallic form proved leſs brittle than in the foregoing experiment; the retort appeared variegated in the ſame manner. On endeavouring to rectify the butter, the retort parted in two by the time that one half had diſtilled.

Amalgamation, Melted Zinc, poured into heated Quickſilver, readily amalgamates: One dram of Zinc, and two or three drams of Mercury form a hard brittle amalgam; one part of Zinc and five of Mercury, a ſoft one. Equal parts of Zinc and Lead, melted together, and poured into ſix times their weight of Quickſilver, yielded a ſoft butyraceous amalgam, which ground with water, gradually threw out the Zinc, whilſt the Lead remained united with the Mercury.

with Lead, It is affirmed in books, that a little Zinc thrown upon melted Lead, will inſtantly take fire, and calcine the Lead. On an ounce of Lead in fuſion, I injected a dram of Zinc, but no flame or calcination enſued: The Lead, when cold, looked brighter, whiter, and harder. Two drams being injected on an ounce, part of the Zinc ſwam long upon the ſurface, and ſeemed averſe to unite with the Lead, though they were frequently ſtirred together. Equal parts united, by a ſufficient heat, into a compound harder and more brittle than the Lead, and which in bending made a crackling noiſe. As no deflagration happened in theſe experiments, I inverted the procedure, melting the Zinc in a crucible by itſelf, and injecting upon it different proportions of Lead: The Zinc now fulgurated inſtantly on the contact of the Lead, and ſublimed into flowers, leaving the Lead in its metallic form at the bottom of the crucible: The flowers were extremely fine, and had often a reddiſh caſt.

compound metals, Pewter, Bronze, &c. The principal uſe of Zinc is in metallic compoſitions (*f*), the baſis of which is always either Copper or Tin: It renders Copper of a yellow or Gold colour, Tin brighter and whiter, and both of them harder and more ſonorous. The finer

(*f*) *Zinc with other metals.*] Zinc does not mingle in fuſion with Biſmuth or the ſemimetallic ſubſtance called Nickel: How carefully ſoever it be ſtirred and mixed with either of theſe, the Zinc, when grown cold, is found diſtinct upon the ſurface, ſo as to be readily ſeparated by a blow. It unites difficultly with Iron, leſs ſo with Copper, eaſily with the other metals.

Combined with Iron or Copper, it renders them more eaſily fuſible, harder, and like itſelf brittle whilſt hot, though conſiderably malleable when leiſurely cooled. It brightens the colour of Iron almoſt into a ſilver hue; and changes that of Copper to a yellow or gold colour——It greatly debaſes the colour of Gold, and deſtroys its malleability; rendering near an hundred times its weight of that moſt ductile metal brittle and intractable. A mixture of equal parts of each is very hard, white, and bears a fine poliſh, and hence is propoſed by Mr. Hellot for making Specula: It is not ſubject to ruſt or tarniſh in the air, like the metals commonly

finer kinds of Pewter have an admixture of Zinc, the proportion of which to the Tin is kept a ſecret by the workmen: It is often very ſmall, and ſometimes does not amount to above a pound in five or ſix hundred pounds of Tin. Princes-metal is a mixture of Zinc and Copper; and all the compound metals made in imitation of Gold are at bottom the ſame, differing only in the proportions and ſome other circumſtances which contribute to the malleability or colour. Mr. Geoffroy, in the French Memoirs for the year 1725, has given an account of ſeveral experiments on this ſubject: The compoſitions which he found to anſwer beſt, are the three following. (1.) Two ounces of Copper, one ounce of Zinc, and four ounces of Reſin: Theſe yielded a pale, but a malleable metal. (2.) Equal parts of Zinc and Braſs: This mixture was much higher coloured than the foregoing, but a good deal more brittle. (3.) One ounce of Copper, ten drams of Zinc, and one dram of Iron. All theſe compoſitions require a conſiderably ſtrong fire for their fuſion. It is obſervable that Mercury-ſublimate ſeems to deſtroy that quality in Zinc by which it makes Copper brittle; and hence is made uſe of by thoſe who bronze Copper, or render it ſuperficially yellow, in order to its being drawn into wire for laces. Such is the ductility of Copper and Zinc ſo prepared, that the wire and ZINC.

monly made uſe of for that purpoſe, of which Copper is the baſis——It improves the colour and luſtre of Lead and Tin, renders them firmer, and conſequently better fitted for ſundry mechanic uſes. Tin, with a ſmall proportion of Zinc, forms a fine kind of Pewter: Lead will bear an equal weight, without loſing too much of its malleability—Malouin obſerves, that Arſenic, which whitens all other metals, renders Zinc black and friable; that when the mixture is performed in cloſe veſſels, an agreeable aromatic odour is perceived on opening them; that Zinc, amalgamated with Mercury and afterwards recovered, proves whiter, harder, and more brittle than before, and no longer crackles on being bent.

Mixtures of Zinc with other metals expoſed to a ſtrong fire, boil and deflagrate more violently than Zinc by itſelf. Some globules of the mixture are uſually thrown off during the ebullition, and ſome part of the metal calcined and volatilized by the burning Zinc: Hence this ſemimetal has been called metallic Nitre. Gold itſelf does not entirely reſiſt its action——It very difficultly volatilizes Copper; and hence the Sublimates obtained in the furnaces in which Braſs is made, or mixtures of Copper and Zinc melted, are rarely found to participate of that metal. On melting Copper and Zinc ſeparately, and then pouring them together, a violent detonation immediately enſued, and above half the mixture was thrown about in globules.

Zinc with Sulphur.] Zinc does not unite in the leaſt with Sulphur or with crude Antimony, which ſcorify all other metallic ſubſtances except Gold and Platina; nor with compoſitions of Sulphur and fixed alcaline Salts, which diſſolve Gold itſelf. Hence Zinc may be purified from the Lead, of which it commonly has ſome admixture, by injecting Sulphur upon it in fuſion; the Lead being abſorbed by the Sulphur, and forming with it a concrete which floats unmelted on the ſurface and may be eaſily ſcummed off.

Zinc with Nitre.] Zinc deflagrates violently with Nitre. Its flowers do not ſenſibly deflagrate, yet alcalize double their weight of the Salt, more readily than Zinc itſelf. The alcaline maſs appears externally greeniſh, internally of a purple colour: It communicates a fine purple to water, and a red to Vinegar. The acetous tincture, inſpiſſated, leaves a tenacious ſubſtance, which ſoon runs in the air into a dark red cauſtic liquor, the alcaheſt of ſome of the pretended adepts. Mr. Hellot obſerves that this liquamen, far from radically diſſolving Gold as it has been ſaid to do, precipitates and revives it from its ſolution in Aqua regis.

ZINC. and laces, notwithſtanding their great tenuity, remain every where coated with the Bronze, and diſcover nothing of the Copper underneath. A certain perſon in Saxony has lately diſcovered a ſubſtance, of which a ſmall portion, injected into a large quantity of melted Copper, changes the Copper into a yellow or Princes-metal: This is perhaps ſome concentrated preparation of Zinc. The original diſcovery of Princes-metal is attributed by ſome to prince Rupert, and from him alſo its name is ſuppoſed to have proceeded: Others obſerve, that it was in uſe long before the time of Rupert, for caſting ſtatues, *&c.* and that the name Princes-metal is no other than a corruption of Bronze metal.

Spelter ſolder. Zinc and Spelter are commonly underſtood, both by chemical writers and by workmen, as ſynonymous names for the white ſemimetal we have been treating of. In England, a yellow metallic body, uſed as a ſolder, is diſtinguiſhed by the name of Spelter, and ſuppoſed by many to be a particular kind of Zinc naturally yellow. I have been told by ſome, that it is found in Cornwall; by others, that it comes from America: But have never met with one who could give any ſatisfactory account of its origin; and ſuſpect it to be no other than an artificial compoſition of Zinc and Copper [which it is now known to be]. Thus much is certain, that pure Zinc is never yellow.

Zinc not artificial. Zinc itſelf has been held by many to be an artificial compound, and many ridiculous conjectures have been advanced about the manner of its production. Some have confounded it with Biſmuth, with Tin, with different metallic mixtures; and Dr. Schmieder, in the *Eph. nat. cur. cent.* 3 & 4. is whimſical enough to believe, that the filaments which we often find hanging in the air in ſummer, from the induſtry of the ſpider, are true flowers of Zinc. Homberg prepared a metalline cobweb-like matter, which it was more natural to miſtake for flowers of Zinc, by expoſing Tin and Iron to Tſchirnhaus's burning-glaſs. I repeated the experiment with the ſame glaſs, and obſerved that as ſoon as ſome Tin was added to the melted Iron, fine ſlender filaments immediately aroſe, and flew all about, ſticking to our clothes, and to the machine. They differed however, even in their obvious appearances from the flowers which Zinc affords, being not only longer, but in ſome degree tough and flexible.

Method of obtaining at Goſlar. The greateſt quantities of Zinc come from the Eaſt-Indies, in large oblong pieces; and from Goſlar, commonly in round cakes or loaves. Of the origin of the Eaſt-India Zinc, we have no certain account: The Goſlarian is extracted from the Lead and Silver-ores of Rammelſberg by a particular contrivance in the ſtructure of the furnace. The Zinc, naturally contained in the ore, ſeparates during the fuſion from the other metallic matters, being elevated by the heat in form of fume, which paſſes into a reſervoir made for that purpoſe in the front wall, over the gutter by which the Lead runs off. The reſervoir for the Zinc is incloſed, on the inſide, by a large flat ſtone, only ſome chinks being left for the fumes to enter; and on the outſide, by another ſtone, which is cloſely luted, and frequently ſprinkled during the proceſs with cold water, to cool and condenſe the fumes. Each ſmelting laſts twenty hours, beginning at ten in the forenoon, and ending at ſix next morning. When the fuſion of the ore is completed, the workman dextrouſly ſtrikes the outer ſtone of the reſervoir with an Iron rod, ſo as to looſen ſome of the luting at the bottom; upon which the Zinc, collected during the proceſs, runs out like Quick-

ſilver:

ſilver: He continues to tap till nothing more will run, then melts the Zinc again in an iron pot, and caſts it into hemiſpherical maſſes. I have ſeveral times been at this work, and kept at it two days and a night together without leaving the furnace. ZINC.

Though a part of the Zinc is thus obtained in its metallic form, a part is alſo diſſipated, and a very conſiderable one adheres to the ſides of the furnace in the form of a calx. This is ſcraped off when the furnace is cold, and employed for the making of Braſs, *&c.* under the name of *Ofenbruch*, or *Cadmia fornacum*. There are ſundry other Lead-ores which yield the ſame kind of Sublimate; but no attempts have been made to extract actual Zinc from them, nor is it generally known that this Sublimate proceeds from Zinc. The produce of Zinc is extremely variable, and depends in great meaſure, not only on the due contrivance of the cavity for receiving it, but on the care of the workman in cooling it with water. At Goſlar, when the due precautions happen to be neglected, there is not ſo much Zinc detained as to be worth collecting.

To change Copper to a yellow colour is one of the moſt diſtinguiſhing characters of Zinc. The *lapis calaminaris*, *cadmia foſſilis*, Calamine or Calamy, is well known to poſſeſs this property, being the ingredient commonly employed for turning Copper into Braſs: It makes a finer Braſs than the *Cadmia fornacum*, the latter participating of the Lead, which the ore it is obtained from abounds with. Calamine appears therefore to belong to the ſame family with Zinc; to be in reality an ore of that ſemimetal, though not hitherto worked for it. CALAMINE. An ore of Zinc.

Calamine is conſiderably ponderous, the more ſo the better; moderately hard and brittle, or of a conſiſtence betwixt that of ſtone and earth; ſometimes whitiſh or grey; ſometimes yellowiſh or of a deep yellow; ſometimes red; ſometimes brown or blackiſh. It is plentiful in ſeveral places of Europe, as Hungary, Tranſylvania, Poland, Spain, Sweden, Bohemia, Saxony, Goſlar, France, and in England, particularly in Somerſetſhire; and the northern parts of Wales. It ſeldom lies very deep, being chiefly found in clayie grounds near the ſurface: In ſome places, it is intermixed with Lead-ores. It is generally waſhed from ſuch impurities as may adhere to it externally, and calcined in kilns, like thoſe in which lime or bricks are burnt, before it is brought into the ſhops or to the Braſs-maker. I have obſerved, in ſome Braſs-works, that when the Calamine had not been calcined ſufficiently, the workmen have been obliged to calcine it over again themſelves. Merret informs us, in his notes on Neri, that it muſt be burnt only to a certain degree; that when too little calcined, it does not unite with the Copper; and that when over calcined, it makes the metal brittle. Natural hiſtory.

The Braſs-makers reduce the calcined mineral into fine powder, in ſtamping-mills turned by water. To an hundred pounds of Copper in ſmall pieces, they take forty pounds or more of the powder mixed with a certain quantity of powdered Charcoal; and divide the mixture into ſeveral crucibles, ſix or eight of which are let down into one furnace ſunk in the ground. The proceſs is no other than a cementation, which is continued for different lengths of time according to the quality of the Calamine, ſometimes for a day and night, Braſs.

CALAMINE. sometimes two, three, and even five days and nights. The Copper being at length changed into Braſs, and brought into fuſion, the crucibles are taken out, one after another, and the metal caſt into a plate betwixt two large flat ſtones prepared for this uſe.

Often one third of the Calamine is taken up by the Copper; though ſome ſorts of Calamine are ſo poor as not to give out above one tenth of their weight (*g*). The Zinc thus introduced into the Copper may be ſeparated by amalgamation with Mercury, which unites with the Copper, and leaves the Zinc untouched; by fuſion with common Salt, which will ſcorify the Zinc; or by fire alone, which will burn and diſſipate it. If braſs-leaf be held in the flame of a candle, the Zinc will inſtantly burn out in a flaſh like lightning, and the leaf will become Copper. It is obſervable that Copper impregnated with Calamine, proves much more malleable, and of a yellower colour, than mixtures of the ſame metal with equivalent proportions of Zinc in ſubſtance; probably from the common ſorts of Zinc participating of Lead: And that though both Zinc and Calamine change Copper to a golden colour, they greatly debaſe the colour of Gold itſelf, rendering it pale or white.

Examined by acids. I examined ſeveral ſorts of Calamine by acid menſtrua, and found that they all nearly agreed. From all the ſorts, the marine acid extracted moſt, and acquired a deep yellow colour; a mark, not of their containing Gold as ſome have fondly ſuppoſed, but Iron: Calcined with Oil or other inflammable matters, they yield actual Iron to the Magnet, and ſome hold ſo much as to afford a ferrugineous Vitriol: The Tinctures made in Aqua fortis are likewiſe yellow, though not ſo deep as thoſe in Spirit of Salt——Out of ſixty grains of a pale reddiſh Calamine, half an ounce of Oil of Vitriol diſſolved ſeven grains, the ſame quantity of Spirit of Vitriol five grains, of Spirit of Nitre eight grains, and Spirit of Salt fourteen grains. Out of ſixty grains of yellow Calamine, half an ounce of Oil of Vitriol diſſolved eight grains, of Spirit of Vitriol ſeven grains, Spirit of Nitre twelve grains, and Spirit of Salt ſeventeen grains. As the vitriolic acid diſſolves ſo little of Calamine, I had little hopes of ſucceeding in an experiment related by a certain writer, of changing green Vitriol into white by precipitation with this foſſil: I proceeded exactly according to his directions, but obtained only a green Vitriol again. Many things are believed to be facts becauſe men of learning have written them, and yet when brought to trial, are found to be falſe.

The Solution in Spirit of Nitre, evaporated to dryneſs, yielded a reddiſh-brown maſs, which on digeſtion with rectified Spirit of Wine, in a cloſe veſſel, exploded and burſt the glaſs. A ſaturated ſolution in the marine acid, concentrated by abſtracting or evaporating part of the liquor, exhibits in the cold an appearance of fine cryſtals, which on applying warmth diſſolve and diſappear. A little

(*g*) *Quantity of Calamine taken up by Copper.*] One third the weight of the Calamine is the largeſt yield at the braſs-works, of which we have any account. This mineral however contains often a conſiderably greater proportion of metallic matter, capable of being imbibed by Copper, or ſeparated, by treating it with inflammable additions in cloſe veſſels, in the form of actual Zinc. From the common Calamine of the ſhops I have gained thirty-three parts on ſixty-four. The foreign Calamines appear, from ſome experiments related by Mr. Marggraf in the Berlin Memoirs, to be leſs rich than ours.

A little of this concentrated ſolution tinges a large quantity of water of a bright yellow colour, and at the ſame time depoſites by degrees a fine, ſpongy, browniſh Precipitate. Glue, diſſolved in this ſolution, and afterwards inſpiſſated, forms an extremely ſlippery tenacious maſs, which does not become dry; and might be of uſe for entangling flies, caterpillars, and other inſects, if it was not too expenſive. Sulphur boiled in the ſolution, ſeems to acquire ſome degree of tranſparency. Theſe experiments are mentioned by Juncker, and it was from thence I was induced to repeat them. I further diſtilled the ſolution with well waſhed ſand; and found in the neck of the retort a little Sublimate, variegated with red, green, yellow and other colours: The ſand appeared ſpongy and reddiſh. The Sublimate liquefied in the air: Digeſted for ſeveral months with highly rectified Spirit of Wine, it gave no appearance of the Oil which Juncker mentions. CALAMINE.

I diſtilled four ounces of the reddiſh and the yellow Calamine in a retort in an open fire. From the reddiſh aroſe a dram and a half of phlegm, which changed Syrup of Violets green; and ſome grains of an ammoniacal Salt, which yielded an urinous ſmell with fixed Alcali, effervеſced with Oil of Vitriol and emitted a ſulphureous ſmell, made no change in the colour of Syrup of Violets, burnt in the fire with a bluiſh flame and ſulphureous fume: The Caput Mortuum was of a browniſh-red colour, weighed three ounces and ſeven drams, and yielded no ſaline matter on elixation with water. From four ounces of the yellow Calamine, there aroſe three ſcruples and a half of phlegm, which changed Syrup of Violets green, but no Sublimate: The reſiduum weighed three ounces ſix drams and a half, looked brighter coloured than the Calamine at firſt, and gave nothing ſaline on elixation. On diſtilling the Calamine with Pot-aſh, no remarkable difference was obſerved in regard to the quantity of Salt or urinous phlegm. A mixture of four ounces of Calamine and eight ounces of Nitre being injected by little and little at a time into a tubulated retort made red-hot, about a dram of Spirit of Nitre came over, and in the neck of the retort was found a various coloured Sublimate: The reſiduum was compact, of a dark red colour, and weighed ten ounces and ſix drams. Calamine mixed with Sal ammoniac, yielded a yellowiſh Sublimate, like that obtained by the ſame means from hæmatites and other ferrugineous minerals; but of a paler colour, as containing leſs Iron. It does not in the leaſt unite with Quickſilver. Examined by diſtillation.

There is another ſubſtance common in the ſhops, which may be referred to this head, as it changes, or ought to change, Copper yellow. This is called Tutty, *Tutia*, and by Lemery *Tuthia*, in conformity perhaps to the Arabic origin which he aſcribes to it, though Avicenna, Serapio, Pliny, and many other ancient writers, (ſome of whom undoubtedly underſtood Arabic) call it *Tutia*. Pomet was the firſt who gave any particular account of this ſubſtance: He ſays it is brought into France from Germany and ſome other places where Braſs or Bronze is made. Lemery adds Sweden, and ſays it comes from Germany, Sweden and other places, *&c.* Savary, after copying theſe authors, makes another addition, that it is one of thoſe commodities which come from the Levant; a circumſtance which ſeems repugnant to the former TUTTY. Enquiry into its production.

TUTTY. part of the account. Avicenna and Serapio ſay it is found in the Indies; and Garcias denies its being met with in any part of the Indies. This gentleman was informed that it is made from the aſhes of a tree growing in Perſia, thence imported to Alexandria, and from thence into Europe. Bontius ſays likewiſe it is prepared in Perſia, but denies that it is from the aſhes of a tree. Juncker, profeſſor of chemiſtry at Hall, relates that it is made in Goſlar and at Schneeberg. And this is all I have found in books about the origin of Tutty.

With regard to Goſlar, I am well acquainted with all the works there, and fully ſatisfied that no Tutty is made at any of them. If made at Schneeberg, it ſurely could not have eſcaped the enquiries of the induſtrious Henckel, who lived many years in that neighbourhood, and ſat in the council of mines; and yet we find him, in his Pyritologia, as much at a loſs about its origin as I am, and obliged to take up with Pomet's falſe account. I have written to Sweden, but there it is unknown. I have been at all the conſiderable founderies of Braſs, Bronze, Bell-metal, &c. in Germany and Holland, that at Woolwich and a noted one in Southwark in England, thoſe of France and Italy, &c. without being able to learn any thing of Tutty, or to find any perſon who knew what it was. Bontius's account, that it is a native earth found in Perſia and uſed as a depilatory, cannot be underſtood of our Tutty, which has no ſuch property.

Of the manner in which Tutty is prepared, and what it really conſiſts of, we know as little as of the places from whence it comes. Thoſe who make it a Sublimate ariſing in the founderies, ſay it concretes upon Iron or earthen cylinders placed in the furnace for that purpoſe, and that it is no other than a ſpecies of *Cadmia fornacum:* Valentini relates, that the cylinders are of wood, a material which would preſently be deſtroyed in the ſituation aſſigned to them.

A careful examination of Tutty itſelf diſcovers more of its origin than we can learn by any other means. Its baſis is apparently an argillaceous earth; among which we may diſcover an admixture of Calamine or *Cadmia fornacum*, ſometimes of Zinc in coarſe powder, ſometimes of Lead-ore, and ſundry other ſubſtances: On the ſurface are often found aſhes or bits of coal, which ſhew it to have been baked in the fire. Some years ago, Tutty was extremely ſcarce and dear at Berlin: All at once the ſhops were ſtocked, and the price fell. The Tutty now introduced had neither the colour nor compactneſs of the ordinary ſorts; nor was it ſo fixed in the fire; one half of it being diſſipated. We may therefore preſume, that Tutty is an artificial compoſition, and that this Tutty had been made, for a preſent advantage, by ſome perſon not thoroughly acquainted with the art.

Deſcription. The better ſorts of Tutty are in ſemicylindrical concave pieces, like the bark of a tree; ponderous, and ſomewhat ſonorous; moderately compact, and generally not eaſy to break; of an aſh or mouſe-grey colour, often with yellow or green variegations; pretty ſmooth on the inſide, full of cavities or protuberances on the outſide. The entire, compact, grey pieces, are preferred; the broken, powdery, crumbly, yellow or reddiſh, rejected. Boecler relates that Tutty has a ſharp taſte, but no ſuch taſte is perceptible in ours.

In

In the following experiments was employed the beſt ſort of Tutty procurable from the ſhops, reduced into powder, in the quantity of ſixty grains with each liquor. (1.) Oil of Vitriol diſſolved fifteen grains, acquired a red colour, and extricated fumes reſembling thoſe of Spirit of Sea-ſalt. (2.) Spirit of Vitriol took up twenty-four grains, and here alſo marine vapours were perceived. (3.) Spirit of Nitre diſſolved more than any of the other acids, namely twenty-eight grains out of the ſixty: The colour of the ſolution was a pale yellow. (4.) Spirit of Salt diſſolved twenty-ſix grains, and acquired a yellow tincture. (5.) Aqua regis diſſolved twenty-five grains, and became likewiſe ſlightly tinctured. (6.) Diſtilled Vinegar took up but two grains. (7.) Oil of Tartar per deliquium had no effect. (8.) Solution of cauſtic Alcali diſſolved ten grains. (9.) Different volatile ſpirits, prepared with fixt alcalies and with Quicklime, neither ſuffered or occaſioned any ſenſible alteration; though ſome report that theſe ſpirits extract from Tutty a blue tincture. Tutty extricates in ſome meaſure the volatile Alcali of Sal ammoniac, abſorbing and detaining the acid of the Salt: Nevertheleſs when Tutty is previouſly diſſolved in acids, volatile alcalies precipitate it. Stahl is not a little ſurprized at theſe ſeemingly oppoſite affinities: But Tutty is by no means the only inſtance of them. Pure calcareous earths exhibit the ſame phænomena: Expoſed to the fire in mixture with Sal ammoniac, they diſengage the Alcali, and unite with the acid; and when diſſolved in the acid, the addition of the volatile Alcali will precipitate the ſame earth by which it had been itſelf expelled before.

TUTTY. Chemical examination.

A piece of compact grey Tutty, heated fifty times red-hot, and quenched as often in diſtilled water, gave no impregnation to the liquor, and did not become crumbly or ſuffer any other ſenſible change than contracting ſome red and other coloured ſpecks. A yellowiſh and more brittle piece crumbled at the twentieth extinction, and changed its colour more than the preceding, but gave out nothing to the water. Tutty treated with inflammable fluxes, gave no metallic Regulus; with Borax, it was reduced into a vitreous ſcoria. Mixed with Charcoal powder, and cemented and fuſed with four times its weight of Copper, it tinged the metal yellowiſh. It were needleſs to proceed further in experiments upon a ſubſtance of ſuch precarious qualities; a ſubſtance of which we ſeldom meet with two ſpecimens entirely alike.

Some other productions of Zinc are mentioned by medicinal and metallurgic writers under various names, *Pompholyx*, *Diphryges*, *Nihil*, *Nihil album*, *Spodium grærorum*, *Cadmia botrites*, *zonites*, *onychites*, *oſtracites*, *placites*, *capnites*, &c. Theſe are truly what Tutty is pretended to be, impure ſublimates or flowers of Zinc, ariſing in the furnaces where Zinc, or Calamine, or compound metals made with them, are worked. A Sublimate of this kind is expected in the ſhops under the name of *Pompholyx* or *Nihil*; but we ſeldom meet with the genuine Pompholyx there; maſſes compoſed chiefly of Chalk with probably a little white Lead, prepared in Saxony, commonly ſupplying its place. This counterfeit ſort is of a pure white colour; the genuine is greyiſh. The very beſt ſort is not equal, for medicinal or other uſes, to the flowers obtained from Zinc itſelf.

POMPHOLYX, &c.

Calamine,

ZINC. Medical history.

Calamine, Tutty, Pompholyx and the flowers of Zinc, are applied externally, in unguents and other forms, as deficcatives and epulotics, againſt running ulcers, excoriations of the ſkin, and defluxions on the eyes. By ſome, they have been exhibited alſo internally: It is ſaid that the flowers, given from ſix to twelve grains, prove ſometimes ſudorific, and ſometimes purgative or emetic: That a Magiſtery precipitated by ſpirit of urine from a ſolution of Calamine in Spirit of Salt, duly edulcorated and dried, is a moderately ſtrong emetic and cathartic: That a ſolution of Calamine in Spirit of Nitre, evaporated to dryneſs and ſlightly calcined, acts, in doſes of ten grains or upwards, as a ſudorific. This preparation has been given by ſeveral perſons in England, and entitled *Sudorificum calaminaris*, and *Cadmia diaphoretica*. But the internal uſe of pure Zinc is ſcarcely adviſable; and that of its crude ore, whoſe contents are variable and uncertain, is ſurely leſs ſo. I knew an oculiſt, who employed this *diaphoretic* in Collyria with great ſucceſs: He digeſted the powder in Spirit of Wine, in the proportion of an ounce to half a pint for a ſtronger preparation, and of two drams to half a pint for a weaker: A little of the filtered liquor was dropt into the eye three or four times a day.

IV. ANTIMONY.

ANTIMONY. Natural hiſtory.

ANTIMONY, (*Antimonium*, *ſtibium*) is a blackiſh mineral ſubſtance, ſtaining the hands, full of long, ſhining, needle-like ſtriæ, hard, brittle, and conſiderably heavy. It is found in different parts of Europe, as Bohemia, Saxony, Tranſylvania, Hungary and France, commonly in mines by itſelf, intermixed with earthy or ſtony matters: Sometimes it is blended with the richer ores of Silver, and renders the extraction of that metal difficult; Antimony volatilizing a part of the Silver, or in the language of the miners, robbing the ore. Antimony is ſeparated from its natural impurities by fuſion in an earthen pot, whoſe bottom is perforated with a number of holes; the fluid Antimony paſſing through, whilſt the unfuſible matters remain behind. The melting veſſel is let into another pot ſunk in the ground, and which ſerves as a receiver: This laſt is of a conical figure, and ſuch accordingly is the ſhape of the loaves of Antimony met with in the ſhops. The juncture of the two veſſels is cloſely luted; the uppermoſt one covered, and a fire made round it; and ſeveral ſets of this apparatus worked at once. In ſome places, inſtead of a pot with a perforated bottom, one is taken which has no bottom, and a perforated iron-plate placed betwixt it and the receiver: But the other method is to be preferred, as Antimony in fuſion is apt to diſſolve a part of the Iron.

Medical hiſtory.

Antimony has been by many eſteemed a poiſon. In 1566, its uſe was prohibited in France by an edict of parliament; and in 1609, one Beſnier was expelled from the faculty for having given it. The edict was repealed in 1650; Antimony having a few years before been received into the number of purgatives, In 1668, a new edict came forth, prohibiting its being uſed by any one but the doctors of the faculty. Others again have been extravagantly fond of it, and aſcribed to it extraordinary virtues, as Alexander von Suchten, Glauber, and Faber: Baſil Valentine ranks it among the wonders of the world, and placed it in a triumphal car. Thus much is certain, that Antimony in its crude

crude ſtate is not a poiſon, but a medicine of great efficacy; an excellent re- ANTIMONY.
ſolvent and purifier of the juices, if given from four grains to half a dram, along with abſorbents: That it is capable of being rendered, by various operations and additions, either truly poiſonous, or more medicinal than in its crude ſtate: That its moſt virulent preparations may, by ſlight managements, be made ſalutary; and its moſt ſalutary ones, virulent.

Antimony is not a pure ſemimetal, but a ſulphurated ſemimetal. Thrown into the fire, it burns with a blue flame and ſulphureous vapours: On digeſting powdered Antimony in Aqua regia, the metallic part is diſſolved, and the Sulphur left. The Sulphur of Antimony, purified from the metallic part, is perfectly the ſame with the common Brimſtone of the ſhops, poſſeſſing the ſame properties, and anſwering the ſame uſes: If the ſemimetal, freed from the Sulphur naturally mixed with it, be afterwards melted with common Brimſtone, it reſumes the appearance and qualities of crude Antimony. Many have imagined, that this mineral, beſides common Sulphur, contains a golden or ſolar Sulphur; becauſe Antimony purifies, and heightens the colour of, Gold, and becauſe it diſſolves, as Gold does, in Aqua regia. But with regard to the ſolubility in Aqua regia, it is not the ſulphureous but the metallic matter of the Antimony that diſſolves: If nothing beſides Gold and Antimony was acted upon by that menſtruum, there might be ſome plauſibility in the argument; but ſurely when ſo many ſubſtances diſſolve in it, as Iron, Copper, Lead, Tin, Quickſilver, Zinc, various earths, *&c.* ſolubility in Aqua regis can be no proof of a ſolar impregnation. In the purification of Gold, the Sulphur of Antimony has no other effect than common Brimſtone would equally produce: When Gold, containing an admixture of other metals, is melted with Antimony; the Sulphur, having little affinity with its own ſemimetal, forſakes it, and unites with the Silver, Copper, or other metallic bodies mixed with the Gold, but has no action on the Gold itſelf: Thus only the impurities of the Gold are combined with the Sulphur of the Antimony, into a ſcoria which flows on the ſurface; whilſt the Gold and the ſemimetal of the Antimony form one compound at the bottom: If this compound be expoſed to a ſtrong fire, and a free draught or blaſt of air, it evaporates in fumes, and leaves the Gold pure behind it. This proceſs ſhews the reſiſtance of Gold to Sulphur, and to the volatilizing power of the antimonial ſemimetal, but ſurely gives no foundation for imagining a ſolar Sulphur to exiſt in Antimony——As Gold is the only metal [Platina excepted] that totally reſiſts Antimony or its Sulphur, this mineral has been called by the chemiſts *Balneum ſolius ſolis*, *balneum regis*, *lupus*, *ultimus judex*, &c. Compoſed of Regulus and Sulphur.

The ſeparation of metallic bodies from Sulphur, by fuſion, is no other than a ſpecies of precipitation, and accordingly is called by ſome dry precipitation; as it depends upon the addition of ſome third ſubſtance, whether metallic or not, to which the Sulphur has a greater affinity than to that metal which it is already combined with: In conſequence of this affinity, the Sulphur in fuſion lets go its metal, to unite with the ſubſtance ſuperadded, and forms with this a light ſcoria, from which the other ſubſides by its own gravity. This is the foundation of all the dry partings of metals: Metallic bodies ſeparated by this dry precipitation are commonly called *Reguli*, eſpecially when Precipitation of metallic Reguli in fuſion.

ANTIMONY. brittle. The metallic part of Antimony, in particular, is diſtinguiſhed by no other name than that of *Regulus* of Antimony.

Proportion of Regulus and Sulphur. The proportion of Regulus and Sulphur in crude Antimony, it is difficult, and ſcarce poſſible to exactly determine; as there is always ſome loſs in purifying either the Sulphur from the Regulus, or the Regulus from the Sulphur. There is reaſon to believe, that the Regulus amounts to one half the quantity of the compound, and rather more than leſs.

Methods of ſeparating the Regulus. The Regulus of Antimony by precipitation is obtained, by melting the Antimony with fixt alcaline Salts, Iron, Copper, Tin, *&c.* the Sulphur having a greater affinity with theſe than with the Regulus, and forſaking the latter to unite with the former. The Regulus prepared with alcalies is called *ſimple*: That with metallic bodies is diſtinguiſhed by the name of the particular metal, *martial*, *venereal*, *jovial*, *&c.* All theſe methods are attended with ſome inconveniencies. Alcaline Salts effectually abſorb the Sulphur; but they form with it a *hepar ſulphuris*, which in fuſion diſſolves all the metals: Hence in proportion as the Regulus is freed from its Sulphur by the Alcali, a part of it is taken up again by the compound which the Sulphur forms with the Alcali: One third, one half, and often three-fourths of the Regulus are thus rediſſolved; and often, we find very little Regulus left. Metallic additions are free from this inconvenience, and conſequently occaſion the yield of Regulus to be much larger: But the Regulus thus obtained is never entirely free from ſome portion of the metal ſuperadded. Some have endeavoured to promote the ſeparation of the Regulus by inflammable additions, as powdered Charcoal, Pitch, Reſin, *&c.* but theſe do not at all mend the matter: Antimony treated with inflammable ſubſtances alone, yields no Regulus; and if alcaline Salts alſo are taken, the inconveniences will ſtill be the ſame as when thoſe Salts are uſed by themſelves. Many have ſubſtituted to alcaline Salts, crude Tartar or a mixture of Tartar and Nitre, and thought that then they employed no alcalies; not aware, that thoſe are the very Salts from which alcalies are produced for chemical uſes by the action of fire; and that they do not here effect the intended ſeparation, till the heat has reduced them to that ſtate. There are however ſome differences obſerved in the quantity of Regulus according to the different additions.

Kunckel has given a method of preparing Regulus of Antimony by calcination. He calcines the Antimony till it ceaſes to emit any ſulphureous ſmell, with care to prevent its running into lumps; then mixes the calx with oil or fat and a little powdered charcoal, puts the mixture into a crucible to melt, and as ſoon as the Regulus begins to ſhew itſelf, injects by degrees ſome powdered Nitre, in the proportion of an ounce to a pound of Antimony: The matter in thin fuſion, being poured out, a pure Regulus is obtained, in much greater quantity than by the foregoing methods. There is another, but more expenſive, way of procuring a large yield of pure Regulus; namely, by extracting the Regulus from the Antimony by acid menſtrua, as Aqua regis or Spirit of Salt; precipitating it from this ſolution; and afterwards reviving the Precipitate, by melting it with inflammable additions.

Chemical properties of the Regulus. Pure Regulus of Antimony, by whatever means obtained, is a bright ſemimetal, reſembling Tin or duſky Silver; without any thing of the bluiſh caſt of

of Zinc, or the yellowiſh one of Biſmuth. It is one of the lighteſt of the metallic bodies, [about ſeven times ſpecifically heavier than water] moderately hard, entirely brittle, and of a ſparkling plated texture. In a fire not very ſtrong, it ſmokes copiouſly, and by degrees totally evaporates: By a gentler fire, continued for ſome time, it is changed into a whitiſh calx; which, on raiſing the heat, melts into a yellowiſh or reddiſh glaſs. Melted with Silver, or the other malleable metals, it renders them hard and brittle. It deſtroys the magnetic power of Iron; which other metallic bodies only weaken in proportion to their quantity. It does not amalgamate, or not without great difficulty, with Mercury: If a mixture of it with Silver and Copper be reduced into fine powder, even thoſe metals will not, in that ſtate, be acted upon by Mercury (*b*).——In the human body, it acts as a virulent emetic and cathartic; and impregnates vegetable acids, as Vinegar and acid Wines, with thoſe virtues, almoſt inexhauſtibly. By Sulphur, and by calcination with Nitre, its malignity is abated, and its emetic power changed into a diaphoretic one. As ſoon as it is reſtored to its pure metallic ſtate, it reſumes its virulence; which may be again deſtroyed, and again reſtored, and almoſt infinitely varied. ANTIMONY. Medical effects of Antimony in different circumſtances.

Hoffman has given an account of the different medicinal effects of Antimony, as depending on its different treatments. He obſerves, (1.) That crude Antimony, on account of the Regulus being corrected by the Sulphur, is not only ſafe, but in many caſes a medicine of great ſervice, both for man and other animals. (2.) That by ſimple fuſion, it acquires a degree of malignity; but a far greater if melted with half its weight of Nitre, which conſumes nearly

(*b*) *Regulus of Antimony with Mercury.*] Common Regulus of Antimony may be amalgamated with Quickſilver, by melting the Regulus, and pouring it, in a ſlender ſtream, into a conſiderable proportion of Mercury made almoſt boiling hot: To prevent any loſs of the Quickſilver, the veſſel may be covered with an iron-plate, and the Regulus poured in through a perforation in the plate. By this method, the union ſucceeds more readily and perfectly, than when water is made to boil upon the ſurface of the Quickſilver, as Henckel directs; the Regulus loſing of its heat, in paſſing through the water, before it comes to the Mercury.

A Regulus prepared from Antimony, by the means of Iron and Chalk, unites readily and perfectly with Mercury, by bare trituration with water, into a firm amalgam. This diſcovery was made by Mr. Pott, and communicated in his *Lithogeognoſia*. He obſerves that four parts of Antimony, with one of Chalk, and two or five parts of Iron, yielded Reguli equally amalgamable; and that Marble and Quick-lime ſucceeded equally with Chalk; but that Clay, Gypſum, and other earths had no effect.

There is one earthy ſubſtance which produces a very remarkable effect upon Antimony; though neither the earth itſelf, nor the change which the Antimony undergoes, have hitherto been duly examined. The earth, called *cawk*, is found in Lead-mines, in whitiſh, moderately compact and ponderous maſſes: It is commonly ſuppoſed a ſpar, but differs from the bodies of that claſs in not being acted upon by acids. If a lump of Cawk, of an ounce or two, be thrown red-hot into ſixteen ounces of melted Antimony, the fuſion continued about two minutes, and the fluid matter poured off; "you will have fifteen ounces, "like poliſhed Steel, and as the moſt re-"fined Quickſilver." *Phil. Tranſ.* N° 110. I have ſeveral times repeated this experiment with ſucceſs: But having once varied it by mixing the Cawk and Antimony together at firſt, a part of the Antimony was converted into a dark-black vitreous matter, and part ſeemed to have ſuffered little change: On the ſurface of the maſs appeared ſome yellow flowers.

ANTIMONY. nearly all the Sulphur, and leaves the Regulus bare. (3.) That Antimony, or its Regulus, mixed with common Salt, calcined over a gentle fire for ſeveral hours and kept continually ſtirring, and afterwards edulcorated with water, yields an aſh-grey calx, which is ſo fixed as to bear a melting heat, and proves a mild and ſafe diaphoretic, void of any malignant or emetic quality. (4.) That Antimony, by calcination with a gentle fire, in an earthen veſſel, in the open air, changes into a calx, which melts difficultly, and which has no malignity. (5.) That if this calx be melted with a ſtrong fire into glaſs, it becomes ſo active, that a few grains ſhall occaſion violent vomiting and purging, or even mortal convulſions and inflammations. (6.) That the powdered Regulus, calcined in a glaſs-vial placed in ſand for ſeveral days, becomes a greyiſh diaphoretic powder; which reduced into Regulus, by fuſion with powdered Charcoal, Nitre, and a little fat, proves again virulent. (7.) That when Antimony is melted with one-fourth its weight of Salt of Tartar, the whole poured into a mould, the ſcoria ſeparated, and the more ponderous matter pulverized; the reddiſh powder thus obtained, is ſalutary: But that when Antimony is melted with three or four times its weight of Salt of Tartar, both the Scoriæ and the Regulus are virulent. (8.) That equal parts of Antimony and Nitre, melted together, yield a virulent maſs; but one part of Antimony, with two or three of Nitre, an uſeful diaphoretic. (9.) That the Regulus, melted with half its weight of Nitre, continues emetic; but that one part of the Regulus, with two and a half of Nitre, becomes diaphoretic. (10.) That on melting the diaphoretic calces with fat, Charcoal powder and Nitre, the virulent Regulus is revived. And thus one preparation may be changed into another, a ſalutary into a poiſonous, and a poiſonous into a ſalutary one.

Preparations. The preparations of Antimony are extremely numerous. Lemery, in his treatiſe on Antimony, deſcribes no leſs than two hundred; among which there are many good, and many uſeleſs ones. That gentleman was an excellent workman, but an unhappy philoſopher: We may depend on his operations, but we are not to truſt his theory. With regard to the antimonials, the greater number even of the common preparations is unneceſſary; many of them differing little from one another, and all of them being either emetic or diaphoretic. For my part, I ſhould be ſatisfied with two, the diaphoretic Antimony and emetic Tartar.

Crude Antimony, as already obſerved, is uſed for purifying the juices, and reſolving obſtructions: It is given likewiſe to cattle, and employed in compoſitions for fire-works, and for the purification of Gold. The preparations of Antimony may be ranged, according to the general operations by which they are produced, under four heads; thoſe obtained by ſolution, by diſtillation, by ſublimation, and by calcination.

Golden Sulphur. If powdered Antimony be boiled in alcaline Lixivia, or Sope leys; the Sulphur, and by the mediation of the Sulphur, a part of the Regulus, will be diſſolved into a yellowiſh red liquor. Any acid added to this ſolution precipitates what the alcaline liquor had taken up, in form of a yellowiſh or reddiſh powder, called *Sulphur* or *golden Sulphur* of Antimony: The powder which ſettles firſt is groſſer and darker coloured than thoſe which follow; it appears of a deep

deed reddiſh brown, whilſt that which ſubſides laſt is of a pale yellow. The firſt is alſo the moſt active. ANTIMONY.

There are ſundry variations of this proceſs, both in regard to the ſolution and the precipitation. Some employ Lime-water for the menſtruum: Others, inſtead of boiling the Antimony in a ſolution of alcaline Salt, melt the Antimony with the Alcali, and boil the ſcoria in water. Some precipitate with one acid, and others with another. Some, that the medicine may with propriety be called *golden*, perform the precipitation with a ſolution of Gold: Others take a ſolution of Vitriol of Iron. A difference in the manner of preparing the ſolution does not ſeem to affect the virtue of the medicine; but a difference in the acid uſed for the precipitation does; different acids having very different effects upon Antimony: Thus whilſt the marine renders it highly corroſive, as in the butter of Antimony, and virulently purgative and emetic, as in the Mercurius vitæ precipitated from that butter; the addition of the nitrous deſtroys the virulence of both preparations, and renders the Antimony mildly diaphoretic.

All the antimonial Sulphurs are emetic and cathartic: Thoſe which precipitate firſt are much more ſtrongly ſo, than the powder which falls laſt: The laſt, precipitates, if they prove emetic once or twice, ceaſe to have that effect upon continuing their uſe, and act chiefly as diaphoretics; and hence are greatly to be preferred to the firſt. Theſe preparations are powerful reſolvents, diaphoretics, purifiers of the blood, antiſpaſmodics; of remarkable efficacy in obſtructions of the viſcera, quartan agues, cutaneous and venereal diſorders, ſuffocative catarrhs, leucophlegmatic and cachectic habits. The doſe of thoſe of the laſt precipitation is about ſix grains: Two grains may be given to a child of two years or even of one year old——A powder is vended by the Carthuſian friars in Paris, at a conſiderable price, as a ſpecific againſt ſundry diſorders; commonly called *poudre des chartreux*, but by themſelves *kermes mineral*. This is no other than a golden Sulphur of Antimony; prepared by digeſting powdered Antimony in an alcaline ley, and at length boiling them together; afterwards filtering the liquor, and ſetting it by in a warm place, till a reddiſh brown Precipitate falls ſpontaneouſly. Kermes mineral.

For diſſolving the Regulus of Antimony without the Sulphur, the moſt concentrated Spirit of Salt, or Aqua regis, is neceſſary. For obtaining the ſolution in Spirit of Salt; Mercury ſublimate and powdered Antimony are mixed together, and digeſted in a glaſs-retort placed in ſand: The marine acid in the Sublimate forſakes the Mercury, and corrodes or diſſolves the antimonial Regulus; whilſt the Mercury of the Sublimate unites with the antimonial Sulphur. But the ſolution of the Regulus, thus effected, cannot be commodiouſly ſeparated from the other matter but by diſtillation: On increaſing the fire, the Regulus ariſes, diſſolved in the concentrated acid not into a liquid form, but into that of a thick unctuous ſubſtance like butter, hence called *butter of Antimony*. The butter liquefies by heat; and requires the cautious application of a live coal, to melt it down from the neck of the retort. By rectification or expoſure to the air, it becomes fluid, but ſtill retains the name of butter: The addition of water, either in its thick or fluid ſtate, by diluting the acid, precipitates the Regulus diſſolved in it. The proportions of Sublimate Butter of Antimony.

ANTIMONY. mate and Antimony commonly employed are, three parts of the former to one of the latter: It is obſervable, that if Regulus of Antimony in fine powder be mixed with Sublimate in the ſame proportion, and the mixture preſſed down cloſe in a narrow mouthed glaſs; the matter will in a little time grow hot ſmoke, efferveſce, melt, and boil. There are various other methods of obtaining the butter of Antimony or a combination of the Regulus of Antimony with marine acid; as, by placing the Regulus in the receiver, and diſtilling over upon it a concentrated marine ſpirit from Sea-ſalt or Sal ammoniac and Oil of Vitriol; or mixing either crude Antimony or the Regulus with common Salt, and diſtilling with the addition of Oil of Vitriol, calcined Vitriol, or ſuch other ſubſtances as may extricate the acid of the Sea-ſalt. If the combinations of Silver or Lead with the marine acid, called *luna cornea* and *ſaturnus corneus*, be mixed with Regulus of Antimony and expoſed to the fire, the acid will forſake thoſe metals, as well as it does Mercury, to unite with the Regulus.

Mercurius vitæ. There are ſundry preparations made from butter of Antimony, as (1.) *Mercurius vitæ* or *pulvis algarathi:* This is no other than the Precipitate which falls, upon mixing the butter with water. It is a violent and unſafe emetic. A Precipitate obtained from the butter by means of highly rectified Spirit of Wine, is ſaid to be more mild and ſafe; to procure, after its action as an emetic is over, ſleep; and during the ſleep, to promote a ſweat. Some employ an alcaline ley for the precipitant, and thus alſo obtain a medicine of leſs violent operation. (2.) *Spiritus vitrioli philoſophicus*, improperly ſo called, as it neither contains any thing vitriolic, nor poſſeſſes any ſingular properties that may entitle it to the appellation philoſophic: It is the liquor that remains after the foregoing precipitation, rectified by diſtillation. (3.) *Bezoar mineral* is prepared, by gradually adding Spirit of Nitre to butter of Antimony placed in a retort, ſo long as any efferveſcence enſues, diſtilling off the ſpirit, and calcining the reſiduum: Some cohobate the ſpirit twice or thrice previous to the calcination, and others employ freſh Spirit of Nitre in each cohobation: This is entirely unneceſſary if the nitrous ſpirit was added at firſt in ſufficient quantity, that is, till it ceaſed to make any efferveſcence with the butter. This preparation may be made more commodiouſly by mixing one part of the *Mercurius vitæ* with two and a half of Nitre, injecting the mixture into a red-hot crucible, and proceeding in the ſame manner as for the calx called diaphoretic Antimony. The Bezoar mineral made in either of theſe ways, proves in no reſpect different from that calx. (4.) The ſpirit diſtilled in making the Bezoar by the firſt of the above methods, is an Aqua regis, commonly diſtinguiſhed by the name of *Spiritus nitri bezoardicus*. (5.) A *lunar bezoardic* is prepared by treating the butter of Antimony with a ſolution of Silver in Aqua fortis inſtead of the acid by itſelf; a *ſolar bezoardic*, by adding a ſolution of Gold to the butter, and then proceeding with Spirit of Nitre as for the ſimple Bezoar mineral; a *martial*, by uſing a ſolution of Iron in the nitrous acid, or mixing Iron with the Regulus previouſly to the diſtillation of the butter; and a *jovial*, by adding Tin to the Regulus. All theſe preparations are very inſignificant.

Philoſophic Spirit of Vitriol.

Bezoar mineral.

Bezoardic Spirit of Nitre.

Clyſſi of Antimony. The *clyſſi* of Antimony are obtained, by mixing equal parts of Antimony and Nitre, or of Antimony, Nitre and Sulphur, and injecting the mixture by a little at a time, into a tubulated retort made red-hot; a large receiver containing

ing this or that diſtilled water, being fitted to the retort: The water, thus impregnated with the nitrous and ſulphureous acid, is to be rectified in a glaſs retort. This liquor has no ſingular qualities to recommend it, and may very well be ſpared: If wanted, it might be procured, without uſing any Antimony or Nitre on purpoſe for it, by collecting the vapour which ariſes during the deflagration in making diaphoretic Antimony. If the Nitre is omitted, and the Antimony diſtilled by itſelf, there ariſes a ſouriſh water or weak Spirit of Sulphur, commonly called *acidum antimonii*. ANTIMONY.

Some make a ſolution of the reguline part of Antimony, by applying the bezoardic Spirit of Nitre to the crude mineral: The ſolution, diluted with water, depoſites a *Mercurius vitæ*, which when prepared in this manner is called *flores antimonii fixiores*. The flowers of Antimony, properly ſo called, are prepared by ſubliming either the crude Antimony or the Regulus into a number of aludels; the fire being kept up ſtrong, and a blaſt of air impelled occaſionally by a pair of bellows upon the matter in the ſubliming pot, to promote its evaporation. We have alſo flowers made by ſubliming, with a gradual fire, a mixture of Regulus of Antimony and Sal ammoniac, grinding the Sublimate with the reſiduum, and repeating the operation till nearly all the Regulus is elevated. We often find three or four kinds of flowers in one ſublimation, differing from one another in their external appearance as well as in quality. In ſubliming the Regulus, there are commonly three ſorts; one of a mealy whiteneſs, one ſparkling, and the third of a beautiful cryſtalline appearance: This laſt is called *Silver flowers* of Antimony. Some flowers may likewiſe be collected in detonating the mixture for diaphoretic Antimony in a tubulated retort. The flowers made from crude Antimony with Sal ammoniac, expoſed to the air, run into a liquor called *Oleum febrifugum*. The antimonial flowers are in general of great activity, and though recommended by ſome as Arcana in particular diſorders, require to be uſed with great caution. Flowers.

We have formerly ſeen, that after the diſtillation of butter of Antimony, the Mercury and the Sulphur, contained in the ingredients made uſe of for that proceſs, remain behind in the retort. This compound appears of a black colour: Urged with a ſtronger fire than that which elevated the butter, it ſublimes into a red maſs called *Cinnabar of Antimony*. This Cinnabar has been by many preferred to the common factitious Cinnabar, but on no juſt foundation: They both conſiſt of Mercury combined with Sulphur; and the only difference betwixt them is, that the antimonial Cinnabar contains ſomewhat more Sulphur than the other, and hence appears of a darker colour. Some have been accuſtomed to ſublime the antimonial Cinnabar a ſecond time, with the addition of a little freſh Mercury, or of ſome calcareous earth to abſorb a part of the Sulphur; and by either of theſe methods they obtain a Cinnabar equal in colour and in every other reſpect to the common ſort. Hoffman has expreſſed himſelf erroneouſly, in ſaying, that the Mercury in Cinnabar of Antimony is fettered by the acid of the Sulphur, and that its revival depends upon the taking away of that acid: It is not the acid, but the whole ſubſtance of the Sulphur, which fetters the Mercury, and which muſt be ſeparated, in order to its revivification, by abſorbent earths, Iron filings, or other abſorbents of Sulphur. A certain writer affirms, that a Cinnabar may be made from Mercury Cinnabar.

and

ANTIMONY. and glaſs of Antimony, and hence infers the exiſtence of ſulphureous particles even in the glaſs. With me, the experiment did not ſucceed, though both crude Quickſilver and corroſive Sublimate were tried.

Calcination. The ſimple calcination of Antimony is performed, by ſpreading the powdered mineral in a flat ſhallow pan, and keeping it over a gentle fire till the Sulphur is diſſipated, and the powder become grey: The powder ſhould be continually ſtirred with a glaſs rod or a tobacco-pipe, and if it happens to run into lumps, it muſt be taken from the fire and pulverized afreſh: The heat ſhould be ſlowly and gradually increaſed, and continued till the matter, ſmelt to whilſt red-hot, diſcovers no ſulphureous odour. This calx is neceſſary for making the glaſs of Antimony: It may be reduced into Regulus by fuſion with inflammable ſubſtances, and the Regulus into crude Antimony again by fuſion with common Sulphur. It is obſervable, that though great part of the Sulphur of the Antimony is diſſipated in this operation, yet the calx weighs more than the Antimony at firſt. Of the matter which exhales, ſo much has been collected as to amount to one eighth of the Antimony.

Glaſs. Glaſs of Antimony is chiefly prepared by ſome particular perſons, at Amſterdam and Rouen, who have furnaces contrived on purpoſe for calcining large quantities of Antimony with little expence of fuel. The glaſs may be eaſily made, by urging the calx in a crucible with a ſtrong fire, and throwing in, towards the end, a little crude Antimony or Sulphur. I have obſerved, and I know of no one who has made the obſervation before me, that a calx of Antimony, prepared with the utmoſt care, will not yield any Glaſs of itſelf, without the acceſſion of ſome inflammable matter; and that after reſiſting an intenſe fire of fuſion, it vitrefies immediately upon the injection of a little Sulphur or Antimony, a ſmall portion of Regulus being at the ſame time revived. The Glaſs turns out nearly of the ſame reddiſh brown colour whether Antimony or Sulphur is uſed; but when Borax is taken to promote the vitrification, it proves of a light citron or amber yellow colour. When the vitrification is completed, the Glaſs is poured on a Copper plate, or into a Copper diſh, or on a flat ſtone. Some adviſe to ſtir it in the crucible with an Iron rod, but all Iron Inſtruments ſhould be avoided; the Iron not only reviving a part of the Regulus, but being itſelf alſo corroded and diſſolved, ſo as to render the Glaſs foul. The Glaſs of Antimony is uſed only for making other emetic preparations, as the emetic Wine, Syrup, Sapa, Oxyſaccharum, Aqua vitæ, *&c.* Some employ it for making the emetic Tartar; boiling the powdered Glaſs in water with a proper quantity of Creme of Tartar, and inſpiſſating the filtered liquor. Some digeſt the Glaſs, reduced into ſubtile powder, in freſh parcels of diſtilled Vinegar, till it no longer gives any tinge to the menſtruum; then inſpiſſate the ſeveral liquors together, and extract a tincture from the reſiduum with Spirit of Wine. The Glaſs has alſo been caſt into drinking veſſels, which communicate an emetic quality to wines that are ſuffered to ſtand in them for any conſiderable time.

Hepar. Equal parts of crude Antimony and Nitre mixed together, ſet on fire and ſuffered to deflagrate in an Iron mortar, which may be covered with a perforated plate, or injected by degrees into an ignited crucible, yield a liver-coloured maſs called *hepar antimonii*, which pulverized and edulcorated with

water is named *crocus metallorum*. Two, three, or even one grain of either of these preparations occasion violent anxieties and vomitings; though a dog will bear a dram, and a horse a whole ounce, without being apparently any otherwise affected than in having the alvine discharge increased. The emetic Wine, emetic Tartar, and other medicines made from the Glass, may also be made from the Crocus. The Crocus is used in some places for an eye-water called *Aqua ophthalmica quercetani*. ANTIMONY.

With regard to emetic Tartar, the practice of crystallizing it is very exceptionable; as the crystals will by no means be uniform in strength, some proving violently and others weakly emetic, and some of them being mere crystals of Tartar, which have shot without any antimonial impregnation at all; the liquor which remains after the crystallization, evaporated to dryness, yields a mass very different from the crystals. I would therefore recommend, whether the Glass or Crocus are made use of, the solution to be gently evaporated to dryness; the matter to be kept constantly stirring, towards the end of the evaporation, as is commonly practised in exsiccating solutions of fixt alcaline Salts; and the whole of the dry residuum to be ground together for a considerable time in a stone mortar. We should be well satisfied of the strength of emetic Tartar before we exhibit it, as there are sundry variations in its preparation, which vary its effects: The use of the Crocus or Glass, the manner in which these have been made, their proportion to the crystals of Tartar, the quantity of water, the length of time that the coction is continued, will all influence the medicine. I have known fatal consequences from inattention to the differences in emetic Tartars: A Dutch physician, who had been accustomed to an emetic Tartar prepared with Salt of Tartar, as described by Morley in the *Collect. Chym. Leydens.* whose dose was ten, twelve, fifteen grains and upwards, prescribed a like dose of emetic Tartar from a German shop, by which the patient vomited to death. I have known also three or four grains of strong emetic Tartar prove mortal. Emetic Tartar.

One part of Antimony and two and a half or three of Nitre, mixed together and deflagrated, yield a calx void of all emetic power, called *diaphoretic Antimony*. If the detonation is performed in a tubulated retort having a large receiver, containing some water, adapted to it; both a clyssus of Antimony, and antimonial flowers, may be obtained at the same time. The calx is to be freed from its saline parts by ablution with water: If the water be duly evaporated and set to shoot, it yields crystals called *antimoniated Nitre*: If distilled Vinegar is added to the liquor, a white Precipitate falls, called *materia perlata* or *Magistery of Antimony*. Some make use of the diaphoretic Antimony without edulcoration; but this practice is not to be approved, the unwashed calx containing different saline matters, whose proportions we cannot be certain of; as the antimoniated Nitre, an alcaline Salt, a vitriolated Nitre produced from the sulphureous acid and the alcaline basis of the Nitre. Powdered Regulus of Antimony, deflagrated in the same manner with twice or thrice its weight of Nitre, affords a calx not different in quality from the preceding, but distinguished by the name of *cerussa Antimonii* or *Antimonium diaphoreticum regulinum*. Some think to improve the virtue of these calces by burning Spirit of Wine upon them, or distilling it off, or treating them with Vinegar: But Spirit of Diaphoretic Antimony.

ANTIMONY. Wine can have no effect, and Vinegar is more likely to deprave than to improve the medicine. That the calces, as ſome pretend, are a mere earth, not different from pounded tobacco-pipes, is apparently falſe, for we can preſently reduce them, by fuſion with inflammable fluxes, into pure Regulus.

The *martial diaphoretic Antimony* or *ſpecific ſtomachic* of Poterius, is prepared by melting equal parts of Antimony and Iron filings, injecting upon them in fuſion thrice their weight of powdered Nitre, and after the detonation is over, edulcorating and drying the calx. The *jovial diaphoretic Antimony* or *antihectic of Poterius*, is made in the ſame manner, from a mixture of Tin and martial Regulus of Antimony, in the proportion of one part of Tin to four of the Regulus. This preparation has no claim to antihectic virtues, nor indeed to any ſalutary operation.

Regulus. The *ſimple Regulus* of Antimony is commonly prepared from equal parts of Antimony, Nitre and Tartar, mixed together and injected into a red-hot crucible: When the whole is thrown in, the crucible is to be covered, a ſtrong fire kept up for a quarter of an hour, and the matter poured out into a conical mould previouſly warmed and rubbed with greaſe. The yield of Regulus will be larger, if the quantity of Nitre is diminiſhed; or if the Nitre and Tartar are deflagrated together, in the proportion of one part of the former to two of the latter, before their mixture with the Antimony: The Salts are reduced by the deflagration into a black alcaline coal; this is the ſubſtance commonly uſed by the chemiſts for promoting the fuſion of metallic calces and reviving them into their metallic form, and hence is diſtinguiſhed by the name of *black flux*. Some have been accuſtomed to ſave the expence of Nitre, by taking Pot-aſh or other alcaline Salts: The Regulus is in both caſes the ſame. When the matter is grown cold, the ſcoriæ found on the ſurface are knocked off, the Regulus reduced into coarſe powder, melted in a freſh crucible, and about one fourth its weight of purified Nitre injected upon it: This depuration may be twice or thrice repeated with ſmaller proportions of Nitre, till the ſcoria become ſemitranſparent and of an amber colour. The depuration with Nitre is never to be omitted, whether the Regulus is prepared in theſe methods, or in Kunckel's more advantageous way, formerly mentioned, of calcining the Antimony and reviving the calx.

Medicinal Regulus. The *Regulus Antimonii medicinalis* is impoperly ſo called, as being only a reddiſh brown maſs, like the *hepar Antimonii*, without any thing of a reguline or metallic appearance: It is named alſo *febrifugum Craanii*, *panacea antimonii*, *magneſia opalina*, *&c.* There are various formulæ of its preparation. Craan takes five parts of Antimony, four of common Salt, and one of Salt of Tartar; and after melting them together for a quarter of an hour, with a ſtrong fire, pours the whole into a greaſed cone. Some phyſicians in England prepare a medicinal Regulus from Antimony and unpurified common Salt, without the Salt of Tartar; and mix this Regulus with Gum guaiacum, againſt ſcrophulous ſwellings and glandular obſtructions. Hoffman on the other hand, takes Salt of Tartar without Sea-ſalt, in the proportion of one part of the Alcali to four of Antimony: and commends the Regulus ſo obtained, as a ſafe and efficacious medicine. The late profeſſor Schulze uſed one part of Nitre to

four of Antimony. All theſe preparations, I preſume, may be well ſpared; and indeed they are already almoſt out of faſhion. ANTIMONY.

The martial Regulus of Antimony is obtained moſt commodiouſly from four parts of powdered Antimony, two parts of Iron nails or wire, and one part of Nitre. The Iron, made red-hot in a crucible, ſoon melts upon adding the Antimony; after which the Nitre is to be injected, the crucible covered, and the matter, when brought into thin fuſion, poured expeditiouſly into a warm greaſed cone. The Regulus, freed from the Scoriæ, is to be melted afreſh, with about one-fourth its weight of Nitre, and this purification, if neceſſary repeated. If the Regulus retains any ſuperfluous Iron, it will look greyiſh, ſpongy, prove hard to break, and difficult of fuſion: In ſuch caſe, the ſcorification of all the Iron by means of Nitre would be a tedious work; but the addition of a little crude Antimony or common Sulphur will abſorb it at once; and the injection of Nitre will now ſoon complete the purification, and render the Regulus of a ſparkling white colour. The ſcoriæ are yellow and ſemitranſparent like amber: If the quantity of Nitre has not been too large, they prove an exceſſively ſtrong fiery Alcali, diſtinguiſhed by the name of *Nitrum cauſticum*. The yellow ſcoriæ, which ſeparate in the depuration of the ſimple Regulus with Nitre, are likewiſe alcaline, but want the cauſticity of theſe: The ſcoriæ produced from the martial Regulus, by calcination with Tartar, take fire on being expoſed to the air. If either Regulus, after due purification, be haſtily poured into the mould whilſt in exceeding thin fuſion, and if the quantity of ſcoria covering the ſurface is conſiderable, the Regulus, when grown cold, exhibits the appearance of a ſtar upon the top. For producing this appearance, there is no occaſion for any particular ſort of Antimony, or any particular Iron, or any particular conſtellation, or ſeaſon, or weather, as many have idly imagined; the whole depending upon the circumſtances abovementioned. If the martial Regulus be melted with an equal quantity of purified Copper, the mixture, inſtead of a ſtar, exhibits a net on the ſurface, called *rete vulcani*——There are ſundry compound Reguli of Antimony, *venereal*, *jovial*, *ſolar*, &c. prepared either by barely melting the Regulus with other metals, or employing the metal in the precipitation of the Regulus at firſt. Different metals abſorb different quantities of Sulphur, and hence require to be taken in different proportions to the Antimony: Thus, of Iron we take half the weight of the Antimony, but of Copper an equal weight, and of Lead twice as much: Tin does not eaſily, in any proportion, precipitate the Regulus. The ſcoria with Tin flow the eaſieſt of all, next thoſe with Silver, then the venereal, after theſe the martial; the moſt difficultly fuſible of all are the ſaturnine——The ſimple Regulus is caſt into cups, which like thoſe made from the Glaſs communicate an emetic quality to wines; and into pills, like ſhot, which prove ſtrongly purgative, and do not loſe their virtue in paſſing through the body; whence their name *pilulæ perpetuæ*.

Martial Regulus.

Cauſtic Nitre.

Stellated Regulus.

There are various tinctures of Antimony, which ſome have fondly imagined to participate of ſolar, venereal, antimonial and other impregnations. They appear to be all no other than ſimple alcaline tinctures; their colour proceeding from the oily matter of the Spirit of Wine heightened by the cauſtic Alcali. Spirit of Wine conſiſts of an Oil highly attenuated and combined with water

Antimonial tinctures.

ANTIMONY. into one ſeemingly homogene liquor: If the moſt highly rectified ſpirit, which exhibits no mark of any phlegm, be employed for making theſe tinctures, it will now yield in diſtillation a good quantity of water; the Oil, before combined with that water, having been abſorbed by the Alcali. If cauſtic alcaline Salt alone, be poured hot into rectified ſpirit, and the mixture digeſted for ſome time, a tincture will be obtained, not diſtinguiſhable from the antimonial. If Sulphur be added in either caſe, the tincture will receive a conſiderable taſte and ſmell from that ingredient. The common tincture of Antimony is made from the Scoriæ of Antimony; and the *tinctura antimonii acris* or *Regulina*, from the *nitrum cauſticum*. There is nothing remarkable in the preparation; the matter being only put as hot as poſſible into the ſpirit, before it can imbibe any moiſture from the air, and the mixture digeſted till the ſpirit appears ſufficiently tinged.

V. ARSENIC.

ARSENIC. THE chemiſts have formed various conjectures about the nature of this ſingular concrete; but have not been able to determine what it really is, or to what claſs of bodies it belongs. They have called it ſulphureous, unctuous, mercurial, a mineral juice, *&c.* without foundation. Boerhaave, in his *Elementa Chemiæ*, ranks it under the head of Sulphurs, and ſays it approaches nearer to the nature of Sulphur than of any other known mixt: It wants however the peculiar qualities by which Sulphur is diſtinguiſhed. Stahl, with greater probability, ſuppoſes it to be of a ſaline nature. In ſome of its ſtates, it apparently poſſeſſes properties attributed to Salts alone; but in other ſtates, it is as obviouſly metallic.

General properties, White Arſenic, or Arſenic ſtrictly ſo called, is a moderately heavy, compact, hard, brittle concrete; of a cryſtalline or vitreous appearance; gradually changing, from expoſure to the air, to a milky hue like that of Porcelane, and at length to the opake whiteneſs of white enamel. The larger maſſes preſerve their tranſparency longer than the ſmall; in a dry, longer than in a moiſt air.

in the fire, In the fire, it neither burns, nor perfectly melts; but totally and readily exhales, in thick fumes, of a ſtrong fetid ſmell reſembling that of Garlic. The fumes, caught in proper veſſels, condenſe, either into cryſtalline maſſes again, or into a white powder; according as the receiver is leſs or more removed from the heat.

metallized by phlogiſton. Mixed with inflammable matters, and expoſed to the fire in a retort or other like veſſel, it aſſumes a metallic appearance. In this ſtate, it greatly reſembles Regulus of Antimony; being, like that ſemimetal, of a bright ſparkling whitiſh colour, a plated or leafy texture, and very brittle: But its whiteneſs ſoon changes in the air to a dark blackiſh hue. It ſtill continues volatile, as in its unmetallic form: It burns, and calcines in the fire, and ſublimes into white Arſenic as at firſt.

Solution in water, Arſenic reduced into fine powder, and boiled in fifteen times its weight of water, totally diſſolves. If the ſolution be evaporated a little, the Arſenic ſhoots, on cooling, into cryſtals; which frequently have a yellowiſh tinge:

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The entire cryſtals are not taken up again by boiling water, but when finely pulverized, they diſſolve as at firſt. The ſolution has a nauſeous taſte, but not a ſaline ſharpneſs. ARSENIC.

Arſenic diſſolves both in acid and in alcaline liquors, but makes no effervescence with either: In fixt alcaline Lixivia it diſſolves very plentifully, in acids more ſparingly. Arſenic in its ſemimetallic form, called Regulus, is eaſier of ſolution than the white Arſenic or calx. in acids and alcalies.

Powdered white Arſenic being digeſted with Oil of Vitriol, and the liquor diſtilled off in a retort; there aroſe at laſt a tranſparent Sublimate like pure Glaſs, but which, loſt its tranſparency in a few days in the air, and became opake like the Arſenic by itſelf. If the fixation of Arſenic is applicable to any uſeful purpoſes, the preſent experiment promiſes means of effecting it: For the Arſenic remaining in the retort after the ſublimation, ſuſtained an open fire without ſuffering any ſenſible alteration; and probably it might be rendered ſtill more fixed by repeating the abſtraction of freſh Oil of Vitriol. Phænomena with different acids.

One part of white Arſenic being diſſolved in two of Oil of Vitriol, and one part of Borax added to the mixture, a ſtrong effervescence enſued, and whilſt the matter continued hot ſome fine capillary flowers as it were, like flowers of Borax, appeared upon the upper part of the Glaſs. By degrees, the liquor grew more and more clear and tranſparent; but on cooling, acquired the colour and conſiſtence of Venice Turpentine. The maſs liquefied, in the ſame manner as Turpentine, on applying heat; but the air ſoon rendered it white, turbid, and untranſparent.

Two drams of Arſenic being boiled in two ounces of good Spirit of Nitre, till greateſt part of the ſpirit had exhaled; and two ounces more of the acid being then added, and the whole well ſtirred together, the Arſenic totally diſſolved. The ſolution, evaporated a little and ſet to cool, yielded ſeveral ſmall quadrangular cryſtals; and the uncryſtallized liquor looked like a pretty thick ſolution of gum Arabic. Henckel obſerves, in his *Pyritologia*, that Arſenic forms a gum-like ſubſtance with Spirit of Nitre; but does not mention the proceſs. It was in conſequence of this hint that I made the two preceding experiments.

A ſolution of Arſenic in pure water changed Syrup of Violets green, but not till they had ſtood together for ſeveral hours. It made no effervescence with any ſaline liquors, acid or alcaline. Nor did I obſerve that any precipitation enſued, as a certain learned author ſays there does, upon mixing with it Oil of Tartar per deliquium, Oil of Vitriol, or Aqua fortis. Oil of Tartar ſcarce occaſioned any ſenſible cloud; but Spirit of Sal ammoniac threw down a little Precipitate. There was no precipitation or change upon mixing it with ſolutions of vitriolated Tartar, purified Nitre, common Salt, Sal mirabile, Alum, Borax, Sal ammoniac, and the ſaline concrete called fixt Sal ammoniac. It precipitated almoſt all metallic ſolutions, but ſome of them ſo ſlowly, that an incurious or haſty obſerver would have pronounced there would be no precipitation. Solution of Gold ſuffered no change at firſt from the admixture of the arſenical ſolution; but on ſtanding for twenty-four hours, it let fall a yellow Precipitate, like Aurum fulminans. Solution of Silver grew immediately turbid and bluiſh; and in twenty-four hours depoſited a dark browniſh grey Precipitate. With various ſaline liquors, and metallic ſolutions.

ARSENIC. cipitate. A ſolution of Iron in Aqua fortis continued at firſt clear; but on ſtanding for twelve hours, a ſmall quantity of a ſubtile yellow powder ſubſided. A ſolution of Copper in Aqua fortis gave a whitiſh calx; and the bluiſh liquor ſtanding above it turned at laſt green. Solution of Tin in Aqua fortis was very copiouſly precipitated. Solution of Lead in Aqua fortis ſuffered no change at firſt, but on ſtanding yielded a plentiful Precipitate. Solution of Mercury in Aqua fortis let fall a plentiful flaky Precipitate; on the ſurface of which were obſerved, next morning, ſome particles inclining to yellow. Solution of Mercury-ſublimate, of Copper in Aqua regia, of Zinc in Aqua fortis, and of Regulus of Antimony, continued clear and ſuffered no precipitation. Biſmuth diſſolved in Aqua fortis is copiouſly precipitated by a large addition of the arſenical liquor, but not at all by a ſmall one. Solution of white Vitriol yields a yellow powder; of green Vitriol, a thick yellow Precipitate; but that of blue Vitriol depoſites very little. Solution of Sugar of Lead, and ſolutions of Sulphur made both with Quicklime and with fixed alcaline Salts, are copiouſly precipitated by the arſenical liquor: The ſulphureous ſolutions are precipitated even by a tincture made from Arſenic with highly rectified Spirit of Wine; from whence it appears that vinous ſpirits diſſolve ſome portion of this concrete. The *liquor ſilicum*, mixed with the watery ſolution of Arſenic, coagulates on ſtanding. I likewiſe diſſolved Arſenic in Oil of Vitriol, Spirit of Nitre, Spirit of Salt, Oil of Tartar per deliquium, and Spirit of Sal ammoniac; and mixed the acid ſolutions with alcalies, and the alcaline ſolutions with acids. No precipitation enſued in any of theſe mixtures, except two; namely, when Oil of Tartar was dropt into the ſolution made by Spirit of Salt, or Spirit of Salt into that made by Oil of Tartar: In both theſe caſes a precipitation happened on ſtanding, moſt readily and plentifully in the laſt.

With Mercury-ſublimate. If Arſenic be mixed with Mercury-ſublimate, and the mixture expoſed to the fire in a retort, the Sublimate will be deſtroyed, or reſolved into its conſtituent parts. Its acid quits the Mercury, and unites with the Arſenic: And there diſtils a Butter or Oil of Arſenic, that is a ſolution of the Arſenic in the marine acid; followed by the revived Mercury. We may judge from hence how little foundation there is for the common report that Mercury-ſublimate is adulterated with Arſenic: It is plain that they cannot be united together by ſublimation, and Arſenic cannot be mixed afterwards with the maſs, as we always meet with it in cakes. The method propoſed for detecting the abuſe, if the abuſe ſhould be practicable, is likewiſe erroneous: It is ſuppoſed, that Sublimate mixed with Arſenic will turn black with alcaline Lixivia, and pure Sublimate not: But Arſenic by itſelf ſtrikes no blackneſs with alcalies, and ſome pure mercurial Sublimates do, probably from their being ſuperſaturated with Mercury.

With Nitre. White Arſenic makes no deflagration with Nitre; but extricates the acid of the Salt in a remarkable manner. If two parts of Nitre and one of Arſenic be committed to diſtillation in a retort, and ſome water placed in the receiver to promote the condenſation of the fumes; a nitrous ſpirit will be obtained, far more volatile, ſubtile and penetrating than common Spirit of Nitre, and of a beautiful blue colour. This ſpirit requires to be kept in veſſels very cloſely ſtopt:

ſtopt: If the air is admitted, its volatile vapours ſoon eſcape, and all its colour vaniſhes (*i*). A part of the Arſenic ariſes diſſolved in the ſpirit, as appears from the liquor making Copper white: What remains, along with the alcaline baſis of the Nitre, proves conſiderably more fixed in the fire than Arſenic by itſelf. ARSENIC.

With alcalies and vitreous matters.

Arſenic is detained alſo in the fire by common alcalies and earths, and may be converted along with them into a true Glaſs: Thus if Arſenic be diſſolved by boiling in a ſolution of alcaline Salt, the liquor inſpiſſated, the dry matter mixed with powdered Flint, and urged with a ſtrong fire as for making common Glaſs, they will all vitrify together. Lemery relates, that in divers operations upon Arſenic in glaſs veſſels, there is often met with a vitrified matter, not diſtinguiſhable from the common Glaſs of which the veſſel is made, except by its being a good deal more brittle. I have often obſerved ſuch a ſubſtance myſelf; but it was only a clear cryſtalline Arſenic, and not a true Glaſs.

With metals.

Arſenic unites in fuſion with all the metals; commonly promotes their fuſibility, and renders them hard and brittle; and changes the coloured ones white. In a ſtrong fire, a part of the Arſenic, evaporating, generally carries off a part of the metal, eſpecially of the imperfect metals; and the remainder of the metal, calcining, vitrifies with the Arſenic. Lead forms with Arſenic a hya-

(*i*) *Arſenic with Nitre.*] Regulus of Arſenic deflagrates ſtrongly with Nitre: The Calx or white Arſenic does not ſenſibly deflagrate, but makes a conſiderable ebullition, and if the operation is performed in open veſſels, alcalizes the Salt. A large portion of the Arſenic remains united with the Alcali, into a ſaline concrete; which deliquiates in the air, and diſſolves in water into a viſcous liquor, excepting a little flaky matter, which reſiſts both liquid menſtrua and fire. The arſenicated Alcali melts eaſily into a kind of pellucid glaſs; which, continued in the fire, emits copious fumes, and becomes more and more opake, and milky, and difficult of fuſion——The ſame kind of arſenicated Salt is obtainable by combining white Arſenic with the common fixed alcalies.

When Arſenic and Nitre are diſtilled in cloſe veſſels; the Arſenic remains combined with the Alcali of the Nitre, into the appearance of a perfect neutral Salt; which diſſolves in water, does not liquefy in the air, ſhoots into regular cryſtals, makes no change in the colour of Syrup of Violets, nor any effervеſcence with alcalies or acids. It nevertheleſs precipitates moſt metallic ſolutions made in acids, its Alcali uniting with the acid, and its Arſenic with the metal. Urged with a ſtrong fire in cloſe veſſels, it ſuffers no change: Even the addition of vitriolic acid does not diſunite the Arſenic from the Alcali. Laid on burning coals, its compoſition is inſtantly reſolved; the Arſenic reviving and evaporating.

The arſenical Calx is found likewiſe to expel the nitrous acid from its combination with the baſis of Sea-ſalt, with common fixt alcalies, with volatile alcalies, and with abſorbent earths; though incapable of expelling the weaker acid of Sea-ſalt from any of theſe. After the expulſion of the nitrous ſpirit, the Arſenic remains always combined with the Alcali or earth into a nutral ſaline concrete: It may even be transferred from one into another, from volatile alcalies into abſorbent earths. The Arſenic is not to be diſunited from the earths, any more than from fixed alcalies, by the ſtrongeſt fire in cloſe veſſels, but readily exhales in open ones on the contact of inflammable matter. Hence certain ores, which emit no arſenical fumes by ſtrong calcination per ſe in the common method, on the addition of a little charcoal yield abundance.

The foregoing obſervations are drawn from a curious ſet of experiments, by Mr. Macquer, in the French Memoirs for the years 1746 and 1748.

ARSENIC. a hyacinth coloured Glaſs, which proves a more powerful flux for earthy, and other refractory bodies, than the pure glaſs of Lead.

Iron may be combined with Arſenic, by mixing the Arſenic with fixt alcaline Salt and ſome inflammable matter, as Sope, powdered Charcoal, Tartar, *&c.* ſt ratifying this mixture in a crucible with thin Iron plates or Iron filings, fitting on the veſſel a cover with a ſmall hole in it, giving at firſt a gentle fire ſuch as the Arſenic by itſelf could bear, and then raiſing the fire as expeditiouſly as poſſible, till the matter is brought into fuſion; or by mixing Arſenic, Tartar, and Iron filings together, injecting them into a crucible ſtrongly heated, and pouring out the matter as ſoon as it appears fluid. Thus we obtain an arſenicated Iron, hard, brittle, and whitiſh.

Copper, combined in like manner with Arſenic, becomes white; and retains ſome degree of malleability, eſpecially if the proportion of Arſenic is not too large, or if the compound is melted once or twice with Tartar and Borax. An over-proportion of Arſenic makes the Copper not only brittle, but of a dark colour, or liable to turn black on expoſure for a few days to the air. The workmen have different methods of preparing white Copper for mechanic uſes. Some take equal parts of Copper and Arſenic, with a little Silver, as one part of Silver, precipitated from Aqua fortis after quartation, to ſixteen of the Copper; ſtratify them together, cement in a cloſe crucible, and then raiſe the fire to fuſion. Some barely melt the Copper with Arſenic fixed by Nitre. Some, inſtead of white Arſenic, take yellow or ſulphurated Arſenic (of which hereafter) and ſublime it from a good quantity of common Salt: Of this Sublimate they inject a little upon melted Copper, which generally receives from thence a very beautiful white colour. Some ſtratify and melt the Copper with fixed Arſenic and a little Luna cornea. Others add a little Zinc; and the more expert artiſts, inſtead of Copper, uſe Braſs. Theſe white metals are made into buckles, candleſticks, and different kinds of ornamental furniture; but are never to be uſed for any veſſels deſigned for containing foods or liquors.

Arſenic debaſes the colour of Silver, renders the metal brittle, and in part volatilizes it. Silver melted in a cloſe veſſel with Arſenic and a little Sulphur, forms a red compound, in ſome meaſure reſembling the red Silver-ore. The arſenical Sublimate obtained from that ore, ſtrongly heated in a cloſe Silver-box, penetrates the metal, and renders it quite porous. Silver cemented with pure Arſenic, remained brittle and pulverable after the Arſenic had been diſſipated by gentle calcination.

Tin melted with Arſenic is ſoon changed in part into a calx; and both the calx and the uncalcined part retain no ſmall proportion of the Arſenic. The Tin, thus arſenicated, appears of a ſparkling white colour, and plated texture, greatly reſembling Zinc. Hence ſome have imagined it to be a true Zinc; though the intrinſic properties of this compound are entirely different from thoſe of that ſemimetal.

Lead melted with Arſenic, begins to boil and ſmoke in a leſs degree of heat than is neceſſary for producing that effect upon pure Lead. A part of the Lead evaporates, part runs into a fuſible ſaffron yellow glaſs, and what retains its metallic form proves brittle and of a dark duſky colour.

Gold

Gold itſelf is not only rendered brittle and deprived of its colour by Arſenic, but volatilized: If the mixture be haſtily urged with a ſtrong fire, a part of the Gold ſublimes. ARSENIC.

Arſenic has different degrees of affinity with the different metals. It forſakes Silver to unite with Lead, and hence in running down the arſenical Silver-ores, the workmen commonly add a large proportion of Lead to abſorb the Arſenic. In like manner, it quits Lead for Tin, Tin for Copper, and Copper for Iron: White Copper melted with Iron filings, recovers its original redneſs, the Arſenic being transferred into the Iron. Copper has a greater affinity with Mercury than it has with Arſenic: Mercury amalgamated with white Copper, takes up only the pure Copper, the Arſenic being rejected to the ſurface. Arſenic is more eaſily ſeparable from all the metals than Sulphur is: Though Sulphur is not rapacious, or apt to volatilize them, like Arſenic, it adheres to them much more ſtrongly. Affinities with metals.

Arſenic is employed for ſundry mechanic uſes; by the dyers, as an ingredient in the compoſitions of ſcarlet and other fine reds; by the girdlers and pinmakers, for whitening their Braſs or Copper; by the goldſmiths, for enamelling; by the glaſs-makers, for promoting the fuſion of the fritt, and the clearneſs and tranſparency of the glaſs; by the porcelane-makers, in white glazings; by the preparers of compound metals, for communicating a Silver whiteneſs to Copper; by the aſſayers, it is uſed, in the form of glaſs, for promoting the ſcorification of refractory ores which participate of Tin and Antimony, and which will not work off but run into lumps in the cupel. I know an artiſt who prepares a beautiful metal, like the fineſt Steel, by melting caſt Iron with Arſenic and Glaſs, and adding a little Tin during the fuſion: The beauty of the metal depends in great meaſure upon the proportions. In Vienna, a metal is made for ornamental uſes, reſembling the fineſt Silver, from Iron, Tin, and Arſenic; perhaps with the addition of a little Copper. Arſenic is uſed alſo in ſolders, or for uniting Iron with Tin, in ſome places in the making of tinned Iron plates. Uſes. Arſenical compound metals.

Arſenic is a moſt violent poiſon to all animals; unleſs the wolf ſhould be an exception, who is ſaid, probably without ſufficient foundation, to be only purged by it. The utmoſt caution is neceſſary, in all operations upon Arſenic, to avoid its fumes: It is on account of the danger attending ſuch operations that this mineral has hitherto been ſo little examined by the chemiſts. The deſtroying of rats, mice, or other domeſtic animals, by means of Arſenic, is full of danger; the operation of the poiſon being ſuch, that great part of it is diſcharged, and the animal induced to drink: Hence foods, liquors, and the provender of cattle, have too often received a poiſonous taint. If we cannot catch thoſe animals, we may nevertheleſs be cleared from them by much ſafer means than the uſe of Arſenic: Freſh nightſhade is their enemy. If the juice of the leaves or berries of that plant, or the diſtilled water of the freſh herb, be made into pellets with meal; the rats, without taſting the pellets, will forſake the places where they are laid. Medical hiſtory.

With regard to the effects of Arſenic in the human body; a nauſea, ſickneſs and reaching commonly enſue in about half an hour after taking it; followed

ARSENIC. by violent vomitings, hiccups, and pains in the ſtomach and bowels: Convulſions and palſies of the limbs preſently ſucceed, with intenſe heats, cold ſweats, palpitations of the heart, extreme anxiety, reſtleſſneſs, proſtration of ſtrength, thirſt and dryneſs of the mouth and throat, loſs of reaſon, and at laſt death. If the quantity taken has been conſiderable, the ſtomach and inteſtines are often found upon diſſection corroded or perforated; though in general the patient expires, before the action of the poiſon has proceeded to ſuch a length. There are many poiſons which act by coagulating the juices; but the operation of Arſenic is erroneouſly ſuppoſed to be of this kind: Arſenic rather liquefies than coagulates the blood, and makes no change in its colour: Of milk, ſaliva, and other animal juices, it rather prevents than promotes the coagulation. It is better to acknowledge our ignorance, than to advance groundleſs conjectures.

Antidotes. Several ſubſtances have been propoſed as antidotes to this poiſon. Thoſe who imagine Arſenic to be an Alcali, recommend acids; and thoſe who imagine it a corroſive acid, direct alcalies for counteracting its effects: But Arſenic is apparently neither one or the other. If rock Cryſtal, or Bezoar, or the roots of the elder-tree, by ſome ſtrongly recommended, have ſeemed to do ſervice where Arſenic had been taken; it was not on thoſe ingredients, but on the oils or fats uſed along with them, that the good effects of the medicine depended. Oils, fats, warm fat broths, freſh butter, milk, taken plentifully and repeatedly, are the only antidotes; both for obtunding the force of the Arſenic, and promoting its diſcharge by vomit. If the vomiting does not freely ſucceed by the liberal uſe of theſe kinds of ſubſtances, ſome mild emetic muſt be called in aid; the expulſion of the poiſon being a principal point. The more threatening ſymptoms being thus removed, oily glyſters, and a gentle laxative are neceſſary, to obtund and evacuate ſuch part of the Arſenic as may have paſſed into the inteſtines; after which, the ſtrength is to be recruited by proper analeptics.

Chemiſtry is capable of converting ſundry poiſons into medicines: Thus the virulent antimonial Regulus is changed by that art into the mild diaphoretic Antimony; the violently corroſive Sublimate of Mercury, into the mild Mercurius dulcis. Some have been hence induced to imagine, that Arſenic alſo might be corrected and rendered ſafe; and have even ventured to put ſo dangerous a ſpeculation in practice: A preparation of Arſenic with Nitre has been actually ſold by certain people about Berlin and in other places, under the title of a ſpecific febrifuge. But Arſenic, however prepared, continues Arſenic ſtill: We can mitigate and obtund, but we cannot deſtroy its power. See Stahl's *Menſis novembris*, entitled *Anchiater ſive venenum pro remedio venditum.*

Effects when externally applied. There are many examples of even the external application of Arſenic, producing dangerous conſequences: Thus Hildanus mentions great debility, a high fever, delirium, anxiety, palpitation of the heart and tremor of the limbs, from ſcarcely a grain of Arſenic applied to an ulcer in the foot. Some arſenical preparations have nevertheleſs been recommended againſt cancers and cancerous ſores: And Arſenic itſelf has been worn on the pit of the ſtomach in times of the plague, as if one poiſon was to be driven out by another. The celebrated Dr. Mead has ſhewn, that the uſe of Arſenic as an antipeſtilential,

proceeded

proceeded from an erroneous opinion of its being the ſame with the ſubſtance recommended in that intention by the Arabians under the name of *darſini*: The *darſini* of the Arabians was no other than Cinnamon, though ſuppoſed, from the affinity in ſound, to have been Arſenic. ARSENIC.

Caſes frequently happen, in which we are called upon to determine whether a particular ſubſtance be Arſenic or not; as when powdery matters are found in the ſtomach of thoſe who are ſuſpected to have died by poiſon. Arſenic, in a ſolid form may be diſtinguiſhed, by its yielding, in the fire, white fumes and a garlic ſmell; and by its whitening Copper. This laſt trial is moſt commodiouſly made, by placing a little of the powder betwixt two clean, poliſhed copper-plates, binding the plates firmly together with wire, cloſing the juncture all round with a good lute, and then heating them red-hot. We may try alſo whether any reguline or ſemimetallic matter is obtainable, by means of Tartar and Suet. Arſenic diſſolved in liquors is much more difficultly diſcovered; and I can ſcarce propoſe any thing in this view, beſides the experiments on ſolution of Arſenic formerly related. But I forbear to ſay any thing further on this head, leſt, in endeavouring to diſcover Arſenic, I ſhould furniſh means for rendering it leſs eaſily diſcoverable. Marks for diſtinguiſhing it.

The principal preparations of Arſenic are, fixed Arſenic and the arſenical magnet. Fixed Arſenic is made by gradually injecting powdered Arſenic into melted Nitre, commonly in the proportion of one part of the former to two of the latter: When the ebullition is over, the crucible is covered, the matter kept melted for a little time with a ſtrong fire, and afterwards edulcorated with water. The arſenical magnet is a mixture of equal parts of pure white Arſenic, Sulphur, and Antimony, reduced ſeparately into fine powder, then mixed, put into a glaſs body ſet in ſand in a crucible, and urged with a very gradual fire, till the matter is melted into a red vitreous maſs reſembling a deep garnet or ruby. We muſt be cautious in handling this arſenical glaſs, as a wound received from it may be dangerous. Preparations.

Pure cryſtalline white Arſenic is never found native in the earth. A powdery white Arſenic is now and then met with in ſome of the Bohemian and Saxon mines; though even this ſeems to be not a natural Arſenic, but to have been ſeparated and ſublimed from the ores, by the wood fires made in the mines for burſting the maſſes of ore. It is obſervable, that Saxony, of all countries in the world, is the richeſt in arſenical ores; and that the richeſt Silver-ores abound with Arſenic. Natural Hiſtory.

Some of the proper ores of Arſenic are of a whitiſh, and others of a blackiſh colour, and both ſorts have more or leſs of a ſparkling metallic aſpect: The firſt are called white Pyritæ, or *miſſpickel*; the latter *fliegenſteinertz*. They conſiſt moſtly of Arſenic, blended with a conſiderable proportion of earthy or ſtony matter, but with little if any admixture of any other metallic body.

The preparation of Arſenic was diſcovered only about two centuries ago. The ancients were unacquainted with our Arſenic; their αρσενικον or αρρενικον being our orpiment. The greateſt quantities are prepared at Geyerſberg, near the village Ehrenfriederſdorf, in Miſnia, from ores brought thither from Schneeberg and other Saxon mines. The ore is thrown into a furnace reſembling Preparation of white Arſenic.

ARSENIC. bling a baking oven; whoſe flew is an horizontal pipe, near an hundred fathoms in length, of conſiderable width at the end where it communicates with the furnace, and growing gradually narrower to the other end. The ore is every now and then ſtirred and turned in the furnace, to promote the extrication of the Arſenic; which ariſes in fumes into the pipe, and there condenſes into a greyiſh or blackiſh powder called *Meal Arſenic*. The meal Arſenic is refined by a ſecond ſublimation in cloſe veſſels, with the addition of a little Pot-aſh, which detains its impurities: In this operation, the fire which elevates the Arſenic heating the receiver, the flowers melt together into the cryſtalline maſſes brought to us. The whiteſt and pureſt Arſenic, ſublimed with a little Oil, from Iron filings, or from any inflammable matter, becomes grey or blackiſh like the crude meal; and becomes white again by a reſublimation from Pot-aſh. Henckel obſerves, that Quickſilver alſo detains this inflammable or colouring matter, and does it more effectually than any other ſubſtance——The ores, particularly the black ſort, ſublimed in cloſe veſſels, without addition, yield a light, porous, foliaceous, Regulus of Arſenic.

Arſenic in ores. The red Silver-ores, ſeveral of the Copper-ores, and moſt of the ores of Tin, abound with Arſenic; which evaporating during the fuſion of the ore, in part condenſes about the top of the furnace, and forms ſublimates of various colours, white, grey, yellowiſh, *&c.* according to the admixture of Sulphur or other matters. The Arſenic carries off in its exhalation ſome portion of the metal: At Andreaſberg, the arſenical vapours which ariſe in the working of Silver-ores, are caught in a proper reſervoir, and ſome Silver recovered from the Sublimate.

COBALT. There is a ſingular ore of Arſenic called Cobalt, *Cobaltum pro cæruleo*, *Cadmia metallica*, *Blaufarben kobold*. This appears of a whitiſh colour, ſomewhat darker than the white Arſenic ores ſtrictly ſo called, and differs from them remarkably in ſome of its properties; yielding, after the diſſipation of its Arſenic, the blue Glaſs called *Smalt*, and the ſubſtance commonly uſed for tinging Glaſs blue under the name of *Zaffre*, *Zaffera*, *Zaffloer*, &c. This ore is moſt plentiful in Saxony, particularly near Schneeberg in the diſtrict of Miſnia. It is found alſo in ſeveral other parts of Europe: At St. Andreaſberg in the Upper Hartz, large quantities have been met with for upwards of twenty years; but the manufacture of Zaffre and Smalt is confined to Saxony alone, no method having been found elſewhere of making the colour ſucceed. Saxony has long ſupplied all the other parts of the world with theſe commodities, and exports them even to the Eaſt-Indies. The general method of preparing them is deſcribed by Kunckel; but there are ſome particular managements in the operation, which the workmen are bound by an oath not to reveal; and a prohibition is laid on the exportation of unmanufactured Cobalt (*k*).

The

(*k*) *Cobalt.*] This mineral, in its purer ſtates, is conſiderably compact and heavy, and not unfrequently of a ſemimetallic appearance. Its texture is always fine; ſometimes granulated, or compoſed of minute grains ranged into ſmall ſtriæ; ſometimes ſmooth and even, without any diſtinguiſhable grain. Its colour is ſometimes a pale iron grey, ſometimes a darker bluiſh or blackiſh grey. From variations in the appearance

The ore is firſt reduced into powder in ſtamping-mills; then calcined, and the Arſenic collected, in the manner above deſcribed. The remaining mineral is pulverized and calcined afreſh, and this repeated perhaps a third time, that the Arſenic may be completely expelled. After the laſt calcination, it is paſſed through a fine ſieve, which is moved by a mill: What will not paſs, is ground and calcined again. The powder thus prepared is fit for making either Zaffre or Smalt. COBALT.

For

pearance of the mineral itſelf, or from its different admixtures, ſome of the mineralogiſts have divided it into diſtinct ſpecies, the principal of which are theſe. (1.) Dark grey Cobalt; compact, ponderous, and of a very fine grain. This ſort is ſaid to be the moſt eſteemed at the Saxon works, and to afford the fineſt blue glaſs. (2.) Bright pale grey or aſh-coloured Cobalt; of a ſomewhat looſer ſtructure, and leſs ponderous. This kind has a great reſemblance to the arſenical Pyritæ, and ſome of the white Silver and Copper ores; from which, thoſe who are accuſtomed to the inſpection of theſe minerals diſtinguiſh it, pretty readily, by the colour of the Cobalt being ſomewhat duller, and its texture finer. (3.) Vitreous Cobalt; in ſtructure reſembling melted ſcoria or glaſs, of a bright bluiſh grey colour; called by the Germans *Schlackenkobold*, ſlag Cobalt. (4.) Cryſtalliform Cobalt; affecting chiefly a cubical figure, ſometimes perfect, but commonly with the angles imperfect. (5.) Specular Cobalt; intermixed with glittering talky flakes. (6.) Earthy Cobalt; blended with various earths into ſoft friable compounds, of a black, yellowiſh, grey, or other colours. (7.) Flowers of Cobalt. Theſe are of a looſe radiated ſtructure, and generally not ſo heavy as the foregoing ores. The external parts are of a fine purpliſh red, a violet, or a peach bloom colour: Sometimes the whole maſs is elegantly tinged with theſe colours throughout, but more commonly the internal parts are of a greyiſh or leaden hue. They are never found in great quantities, or forming regular veins; but only in detached maſſes, lodged in clefts of ſtones, in places to which the air has had free acceſs. They appear to proceed from a ſpontaneous reſolution of ſome of the foregoing minerals; moſt of which are found upon experiment to yield nearly ſimilar efflorescences on being expoſed in heaps for a length of time to a moiſt air. Wherever the workmen meet with theſe flowers, they expect a rich vein of Cobalt in the neighbourhood.

The Cobalt mines of Schneeberg are ſaid to be two or three hundred fathoms deep; and the Cobalt lodged at great depths to be of a better quality than that which is near the ſurface. The Schneeberg hill, according to the ancient chronicles of Saxony, yielded at firſt only an Iron ore; which on ſinking deeper, about the beginning of the fourteenth century, was ſucceeded by a very rich ore of Silver: This alſo, being at length exhauſted, gave place to Cobalts. Some pieces of the Cobalt ores are ſtill found to participate of Silver, and even of Gold: Schluter relates, that he has ſometimes obtained after the proportion of three ounces of Gold and upwards upon the hundred pounds. Theſe metals however, far from being eſſential, as ſome have raſhly ſuppoſed, to all Cobalts, are entirely accidental even to this: Nor are they equally diffuſed through thoſe maſſes in which they happen to be lodged; different pieces containing different proportions, and ſome none at all.

Cobalt has been met with in ſome parts of England; at Mendip hills in Somerſetſhire, and in Cornwall; in which laſt county it has of late been dug in conſiderable quantity, though not entirely agreeing in quality to the accounts given by authors of the ſorts which are manufactured in Saxony. It is ſuppoſed that the Chineſe, and more particularly the Japoneſe, had formerly mines of an excellent Cobalt, with which were painted the fine blues of their ancient porcelanes; but that theſe mines are now exhauſted, and that the inferior blues of their preſent ware are painted with the Saxon Zaffre imported to them by the Dutch.

COBALT. Zaffre. For Zaffre, a quantity of Flints, or of the flinty ſtones found adhering to ores and called by the miners *quartz*, is reduced into a fine powder, and ſifted. One part of the calcined Cobalt is mixed with two, three or more parts of the powdered Flint, according as the Zaffre is intended to be of the beſt or of an inferior kind. This mixture is moiſtened with water, and preſſed cloſe into wooden caſks for exportation. On ſtanding, it acquires by degrees a ſtony hardneſs; though if no water is added, it continues powdery or crumbly. It is uſed for tinging Glaſs of various ſhades of blue; and for the blue glazing of earthen ware. I have known Lapis lazuli imitated with it.

Smalt. Smalt is made by mixing the calcined Cobalt with a certain proportion of ſand and Pot-aſh, the common ingredients of Glaſs, and vitrifying the mixture with a ſtrong fire: After the fuſion, a metallic matter, called Regulus of Cobalt, is commonly found at the bottom: This is employed in ſubſequent vitrifications. The whiter the ſand, and the purer the Pot-aſh, the finer will be the colour of the Glaſs; and the ſmaller the proportion of theſe ingredients, the deeper the colour: Hence the different ſortments of Smalt, common, good, fine, and ſuperfine. The Glaſs of each kind is ſtamped in mills, ground betwixt two hard ſtones, waſhed, further ſorted, dried and packed up (*l*).

White

(*l*) *Zaffre and Smalt.*] The preparation of theſe concretes was long kept an entire ſecret, and their origin in general unknown. Many have ſuppoſed Zaffre to be a native earth or ſtone; and even the learned Dr. Merret, after rejecting this opinion, endeavours to eſtabliſh a no leſs erroneous one, that it is a compound of Braſs, Calamine and Sand. Libavius however, ſo early as the year 1506, gave ſome account of its true production: He ſays that, after the eliquation of Biſmuth from its ore, *recrementa in lignis & fovea ſubſiſtunt .... quæ .... reverberii furno exercitata, in lazurium figulorum vitrariorumque & ſimilium tranſmutantur, titulo zapharæ.* Kunckel was the firſt who gave any circumſtantial detail of the method of preparing theſe ſubſtances; and to his account ſome later writers have added further particulars. As attempts are making to introduce this manufacture into England, it may be proper to collect into one view all the information we can procure from them in regard to the management of the proceſs in Saxony.

The Cobalt, taken out of the mine, is broken with hammers, into pieces about the ſize of a hen's egg; and the ſtony involucrum, with ſuch other heterogeneous matters as are diſtinguiſhable by the eye, as much as poſſible ſeparated. In this ſtate, it is aſſayed, valued, taxed, tithed, and delivered to the manufactures——In digging the mines, the workmen frequently meet with hard ſandy maſſes cutting and interrupting the vein. Theſe are broken in mills; and the Cobalt, that had been imbedded in them, ſeparated by ſieves.

The mineral, brought to the manufactures, is pounded in ſtamping-mills, and ſifted through braſs-wire ſieves: According to ſome, the lighter earthy parts are waſhed off by water. It is then calcined, in a large flat-bottomed, arched furnace, reſembling a baking oven, in which the flame of the wood reverberates upon the ore. The mineral is occaſionally ſtirred or turned during the calcination, with long handled iron-hooks or rakes; and the proceſs continued till it ceaſes to emit any fume: An hundred pounds are ſaid to loſe twenty or thirty.

Some relate, that the calcination is repeated ſeveral times, the ore being taken out and ground into powder each time; others, that it is calcined but once, and the calcination continued from four to nine hours, according to the quality of the Cobalt. Some of the aſſayers lay great ſtreſs on the degree of calcination; and report that on this circumſtance, not only the beauty of the colour, but the quantity of coloured glaſs obtainable, in great meaſure depend; and that the degree of calcination which ſome Cobalts require, would be injurious

jurious to others. Some, however, ſeem to be of opinion, that Cobalts may be aſſayed with ſufficient accuracy, both in regard to colour and quantity, without any calcination at all, by barely melting the ore with Borax——The Cobalt taken out of the calcining furnace is paſſed through very cloſe braſs-wire ſieves; and ſuch part as has concreted into lumps, pounded and ſifted afreſh, till the whole is reduced into fine powder.

During the preparation of the Cobalt, ſome Flints are calcined in another furnace, and thrown red-hot into water; by which they are rendered friable and eaſily pulverable. The pureſt and whiteſt ſtones are made choice of; or ſuch at leaſt as become white by calcination. In want of theſe, white ſand is uſed.

Zaffre is compoſed of one part of the calcined Cobalt, and one or two of the calcined Flint, mixed together by ſhaking in a wooden box and ſifting, and then moiſtened with water. Macquer and ſome others report, that a certain quantity of Potaſh is added to the above mixture, and the whole imperfectly melted. This account has little probability; as the ſtony powder is very diſtinguiſhable in Zaffre, without any appearance of its having been united with the Cobalt by fuſion; and as the maſſes have the ſhape of the wooden tubs in which they are brought to us, and conſequently cannot owe their hardneſs to fire.

For making the blue Glaſs, called in the maſs *Smalt*, and when powdered *Smalts* or *powder blue*; one part of the calcined ore is mixed with one, two or more of the Flint, and one or more of Potaſh; and the mixture melted in large crucibles, in a furnace much reſembling that of the glaſs-houſe. In each furnace are generally ſix crucibles, placed about the middle of its height.

The furnace has two doors, one in the front, the other behind: Through the latter common billets are put in; through the former, ſplit wood, dried almoſt to Charcoal in an adjoining oven heated by the furnace. In the front door is an aperture, for introducing ſmall eſſays, which is occaſionally cloſed with a piece of loam. In each ſide are three apertures for conveying the matter into the crucibles, and, after fuſion, taking it out with Iron ladles: Above theſe are three others, which are opened occaſionally for introducing the tongs to move or ſettle the crucibles: At the bottom are two more apertures, for taking out the aſhes and ſuch part of the Glaſs as may have run out and fallen down among them; this is melted over again.

After the fire has been continued for ſix hours, the matter is ſtirred every quarter of an hour, with iron rods, to make the mixture the more equal: The fire is kept up in all, for the beſt Smalt twelve hours, for the inferior kinds ten or eight. The mark of ſufficient vitrification is, the Glaſs which adheres to the Iron ſtirrer drawing out into a fine thread. The whole is now taken out with ladles, and poured into a tub of cold water, to render it more eaſily pulverable.

At the bottom of the crucibles is found a metalline Regulus, of a whitiſh colour, inclining to red, and extremely brittle. When the crucibles have become unfit for any further fuſions of the Glaſs, theſe Reguli are melted in them, and are thus reſolved into two diſtinct metallic bodies, one which falls to the bottom, and another which floats above. The firſt is ſaid to be Biſmuth: The latter is a ſemimetal of a different kind, which yields a blue Glaſs, and accordingly is pulverized and added in freſh mixtures.

The Glaſs appears in the maſs of an opake deep blue, almoſt black; when reduced into moderately fine powder, of a pleaſant light blue: The further it is comminuted, the paler. It is firſt beat in a ſtamping-mill, and paſſed through a braſs-wire ſieve, an iron one being apt to ruſt and ſpoil the colour; after which, it is ground with water, on a ſmooth hard ſtone placed at the bottom of a large vat or tub, by two other hard ſtones turning vertically: The water, loaded with the fine powder, is let off by cocks into other veſſels, and ſuffered to ſettle: After the coloured powder has ſubſided, a white one remains ſuſpended in the water, which is now poured off, that the white matter may ſettle by itſelf: This is employed in freſh mixtures, in the room of Flint and Potaſh. The coloured powder is waſhed again, dried in a ſtove, paſſed through fine ſieves, and divided into different ſortments, according to the fineneſs of the powder and the beauty of the colour. In the laſt place, it is moiſtened with a

little

COBALT. little water, and packed up in caſks for exportation.

The richneſs of Cobalt is judged from the quantity of Flint and Potaſh with which it will form a ſufficiently deep powder blue. The manufactures are provided with aſſayers, for determining the quantities which different parcels of the ore will bear. The produce of Smalt appears to be never leſs than equal, nor more than four times the weight of the crude ore.

Chemical hiſtory of Cobalt.] The colouring matter of Cobalt appears, not, as has been generally ſuppoſed, to be an earth, but a ſemimetal, of a peculiar kind, eſſentially diſtinct from all the others; revivable, in its proper metallic form, either from the blue Glaſs or the calcined Cobalt, by fuſion with the common inflammable fluxes. To Dr. Brandt, of the Swediſh Academy, we owe the firſt knowledge of this ſubſtance as being a ſemimetal *ſui generis:* It is called *Regulus of Cobalt.*

Cobalt may be looked upon as the ore of this ſemimetal: Its other contents are as various and inconſtant as thoſe of any other ores. Almoſt all Cobalts contain a large admixture of Arſenic, ſome of Iron, and others of Biſmuth: The greater number participate alſo of another new ſemimetal, firſt diſcovered by Mr. Cronſtedt in the year 1751, and called, from the name of the mineral which yields it moſt plentifully, *Nickel.* The two metallic Reguli, which ſeparate in making the Glaſs, appear to be Biſmuth, and a part of the tinging Regulus of the Cobalt; for it is a property of theſe two ſemimetals not to mingle in fuſion with one another.

The blue Glaſs depends on the vitrification of the colouring ſemimetal; and metallic ſubſtances in general cannot be vitrified, or combined with vitreous matters, till they are deprived of their metallic form, and changed into calces. Moſt metals are naturally, in their ores, in the ſtate of calx: The Regulus of Cobalt is often naturally metallic, and ſubſides in its proper form upon bringing the ore into fuſion, without any of the inflammable additions, which moſt other ores require for the revival of their metal. Several ſpecimens of Engliſh Cobalt, moderately roaſted till greateſt part of the Arſenic was judged to be diſſipated, and then melted with different vitreous compoſitions, yielded a large portion of Regulus, the Glaſs acquiring only a browniſh or blackiſh colour probably from ferrugineous or other heterogeneous admixtures: On ſtrongly calcining the mineral, by long continued fire or by Nitre, the Glaſs turned out blue, and little or no metallic matter ſeparated.

REGULUS *of* COBALT.

REgulus of Cobalt is a brittle ſemimetal, fuſible in a moderate red heat, nearly the ſame with that in which Silver melts. On continuing the fire, it changes ſlowly into a blackiſh calx; which urged with a very violent fire, runs at length into a bluiſh black Glaſs. By the addition of different proportions of vitreous matters that have no colour, all the different ſhades may be obtained, from the deepeſt to the lighteſt blue. The glaſſes that are moſt loaded with colour, if held in the flame of a candle, crackle, ſwell, and become white.

It does not amalgamate with Mercury, nor mingle in fuſion with Biſmuth: With this laſt it is rendered miſcible by the mediation of Nickel or of Regulus of Antimony: With all the other metals, it mingles readily. It whitens Copper, and renders it brittle, but ſeems remarkably to improve the malleability of Iron: Brandt relates, that the metal obtained in fuſion from a ferrugineous Cobalt-ore, and which was found to be compoſed of Iron with a conſiderable proportion of this Regulus, proved as malleable as the beſt forged Iron: This compound, calcined and vitrified, yielded a good Smalt; the black Glaſs, which Iron affords, ſeeming to be of little injury to the blue of the Cobalt.

Regulus of Cobalt, both in its metallic form and in that of a calx, diſſolves readily in Aqua fortis into a red liquor. As few metallic bodies beſides are acted upon by that acid when fully calcined, and as thoſe that are do not influence the colour; we are hence furniſhed with means of diſcovering this Regulus in ores after ſtrong calcination, whatever other metal they may contain.

Solutions of the ſemimetal, or tinctures of the calcined ore, made in the pure nitrous acid, ſuffer no change of colour from heat. If Sea-ſalt or its acid is added, they aſſume

White Arſenic, ſublimed with one tenth its weight of Sulphur, forms a yellow compound, which melts together, if the receiver is heated, into ſemitranſparent cryſtalline maſſes, called *yellow Arſenic*. If the quantity of Sulphur is doubled, ARSENIC. Yellow and red Arſenic.

aſſume a deep emerald green when moderately warmed, and on cooling become red again as at firſt: Duly inſpiſſated, they yield roſe-coloured cryſtals, which change their colour in the ſame manner. See p. 114.

Pure Spirit of Salt diſſolves this ſemimetal into a reddiſh yellow liquor, which inſtantly becomes green from a very gentle warmth. On ſaturating the ſolution with urinous ſpirits, the Precipitate appears at firſt white, but afterwards becomes blue, and at length yellow.

The vitriolic acid diſſolves this ſemimetal more ſlowly than the two foregoing. The ſolution is of a roſe-colour, and ſuffers no change from heat; but in evaporation, it throws off to the ſides of the glaſs a blue powder, which on cooling grows white. Fixt alcalies precipitate from this ſolution a white powder, volatile ſpirits a greyiſh one; On adding more of the ſpirit, the Precipitate is taken up again, and the liquor appears of a beautiful red.

This ſemimetal is precipitated from acids by Zinc, not by Iron.

NICKEL.

NIckel is a white ſemimetal, when compared with Silver inclining a little to reddiſh, of a cloſe texture, and very bright. Its ſpecific gravity is to that of water nearly as $8\frac{1}{2}$ to 1.

It melts in a ſtrong red or light white heat; and on continuing the fire riſes up into little efflorescences, which change at length into a deep green calx. By a longer continuance of an intenſe fire, the calx becomes brown, but does not vitrify, nor is it diſpoſed to vitrification by the addition of Glaſs. Nevertheleſs Borax, fuſed with the ſemimetal itſelf, acquires a conſiderable reddiſh brown tinge: This vitreous matter, further urged, becomes violet, and at laſt colourleſs, like glaſſes tinged with Manganeſe. Mixtures of Nickel, Regulus of Cobalt and Iron, being ſlightly calcined and fuſed with Borax, the Iron ſeparates firſt in form of a black Glaſs; on repetitions of the proceſs, the Regulus of Cobalt vitrifies, blue; leaving behind the pure Nickel, more difficultly vitreſcible than any other of the imperfect metals.

Nickel makes no conſiderable detonation with Nitre; and is very ſlowly corroded by it into a yellowiſh green fuſible ſcoria. With Sulphur it has a great affinity, abſorbing it from moſt, if not all the other metallic bodies, and detaining it in a very ſtrong fire; even the calces, thoroughly burnt, perfectly unite with it. The ſulphurated Nickel is externally of a bright metallic appearance, internally yellow, very hard, and compact as Steel: It eaſily calcines; and, before a bellows, throws out red ſparkles with conſiderable noiſe.

It refuſes any degree of union with Silver, Quickſilver and Zinc; but mingles readily with all the other metals, and proves a medium for uniting two repugnant ones, Biſmuth and Regulus of Cobalt. It renders the malleable metals hard and brittle, whitens Gold and Copper, and diſpoſes the latter to tarniſh quickly in the air.

It diſſolves with eaſe in the nitrous and marine acids into a deep green liquor: Hence the green tincture which ſome ſorts of Cobalt communicate to theſe menſtrua, and which has generally been attributed to Copper. It is not acted on by the vitriolic acid, whether concentrated or diluted. It is not precipitated from acids by any metal; and but ſlowly by alcaline Salts, into a greeniſh white powder: Volatile alcalies, added in larger quantity than is ſufficient to precipitate it, take it up again, the liquor appearing blue.

This ſemimetal, from its great affinity with acids and with Sulphur, and its entire repugnancy to Silver, promiſes to be an uſeful addition for the reduction of Luna cornea and ſulphurated Silver. Mr. Cronſtedt, (from whom theſe obſervations are extracted) made ſeveral trials of this kind, and conſtantly found the Silver of perfect purity, lying diſtinct from the Nickel. See the *Svenſka vetenſkaps academiens handlingar, ärs* 1751 & 1754.

ARSENIC. doubled, the compound proves more opake, and of a fine red colour, and hence is called *red Arſenic*. This is of a leſs beautiful red than the combination of Sulphur with Mercury, that is, Cinnabar; and has its colour debaſed, whilſt that of Cinnabar is improved, by grinding into fine powder. If the quantity of Sulphur is a little increaſed above the proportion which affords the yellow Arſenic, an orange coloured Sublimate is obtained. The more the Sulphur is increaſed, to a certain point, the Sublimate proves the redder, and more volatile. When equal parts of each are uſed, the dark red colour is diluted into an aurora, and the mixt concretes into a beautiful tranſparent maſs, called ruby of Sulphur or of Arſenic, or golden Sulphur.

The workmen, in making the red and yellow Arſenics, take, inſtead of white cryſtalline Arſenic, the rough meal as it firſt ſublimes from the ore. Sometimes they mix the meal Arſenic with ſulphureous ores inſtead of Sulphur itſelf, or Sulphur with the arſenical ores; and ſometimes they extract yellow or red Arſenics by one ſingle ſublimation from minerals in which Arſenic and Sulphur are naturally contained. Henckel relates, that the preparation of red and yellow Arſenic, with pure white cryſtalline Arſenic and pure Sulphur, does not ſucceed, or not without great difficulty. But if pure white cryſtalline Arſenic be mixed with one tenth its weight of pure Sulphur, they may be eaſily melted together, in a glaſs body, into a ſemitranſparent, orange-coloured or reddiſh maſs, which ſublimes into a ſemitranſparent, citron yellow, hard, brittle, ſublimate; a minute portion of more fixed matter remaining at the bottom. The proportions of Arſenic and Sulphur in theſe kinds of compoſitions, may be judged from their ſpecific gravity; the gravity of Arſenic being to that of Gold as 1 to 5, whilſt the gravity of Sulphur is to Gold only as 1 to 9: Hence the more Sulphur they contain, the lighter; and the more Arſenic, the heavier they will be. The poiſonous quality, which the Arſenic poſſeſſes by itſelf, is, in theſe, conſiderably abated by the Sulphur. They are nevertheleſs far from being innocent: Thoſe who are employed in grinding them for the uſe of painters, are apt to become paralytic.

Natural mixtures of Arſenic and Sulphur, called *Auripigmenta* or Orpiments, *realgar*, *riſigal*, *ſandaracha*, are not unfrequently met with in the earth, particularly in the eaſtern countries. Mr. Pott has given an excellent diſſertation on Orpiment, from which it may be proper to make a ſhort extract.

ORPIMENT. Natural Hiſtory. "Auripigmentum, ſo called from its being uſed as a gold-coloured Pigment, is the αρσενικον and αρρενικον of the Greeks; the *Harnat*, *Zarnich* or *Zirnich* of the Arabians; the *Fumus rubeus*, *Gummi Paradiſi*, &c. of the alchemiſts. It is commonly ſuppoſed to be the ſame with the factitious yellow Arſenic, and to be poſſeſſed of a poiſonous quality; but it is neither one, nor the other. This error ſeems to have proceeded from Agricola's relation, copied by many later writers, that white Arſenic is prepared from Orpiment and common Salt ſublimed together. Hoffman made trial of ſuch a compoſition, but obtained from it no white Arſenic.

Orpiment is a native foſſil, found chiefly in Turkey and Natolia. Some is met with alſo in Bohemia, Hungary, and Luſatia near Sorau, but inferior in goodneſs to that of Turkey. The beſt ſort is of a lively gold-yellow and green

colour, here and there intermixed with pieces of a vermilion red; of a ſhattery foliaceous texture, ſomewhat flexible, ſoft to the touch like Talc, and ſparkling when broke. The inferior kinds are of a dead yellow, inclining more to greeniſh; and want the ſparkling appearance of the foregoing. ORPIMENT.

It burns in the fire, but not very eaſily, with a deep blue, or a dark bluiſh white flame and a ſulphureous ſmell; and at the ſame time melts and becomes red. If the fire is continued, it ariſes in white or rather yellowiſh white fumes, which condenſe partly into reddiſh and partly into white flowers; an earthy, ſandy, or ſtony matter remaining behind. Hoffman obſerves, that the fume of Orpiment ſtains a knife of a yellowiſh white and reddiſh colour; and ſays that the red Arſenic of the ancients was no other than Orpiment melted into a cinnabarine red maſs. Cramer relates, that as ſoon as it burns it melts, and being then poured out upon a clean Marble or Iron plate, forms on cooling a deep red, ſemitranſparent, compact, brittle ſubſtance; leaving a porous ſparkling matter, reſembling an imperfect ſcoria, leſs fuſible than the Orpiment at firſt, and which in a ſtrong fire falls into a grey earth. Examined by fire.

Orpiment conſiſts of Sulphur and Arſenic. Some affirm that it has a corroſive quality, ſo as to make the hair fall off, and hence ſuppoſe it to conſiſt of acrimonious Salts. But Orpiment of itſelf has no ſuch power: It is a mixture of it with Quick-lime which has that effect, and Quick-lime will produce the ſame effect without it. A Lixivium made by boiling Orpiment in Lime-water, gives colour to inviſible writings with the ſympathetic Ink. The ſympathetic Ink is a ſolution of Litharge in Vinegar, or of Sugar of Lead. This ſolution, written with on paper, leaves no ſtain, any more than pure water: But if a piece of bibulous paper, dipt in the ſolution of Orpiment and thoroughly dried, be laid upon the writing, the characters will preſently become black and legible. The ſame bibulous paper impregnated with the Orpiment, will anſwer repeatedly for a length of time: It will likewiſe produce its effect, though more ſlowly, without the immediate contact of the writing, and even with a thick book interpoſed betwixt them. A like black colour reſults upon mixing the ſolutions of Orpiment and of Lead together; and hence we are furniſhed with means for diſcovering the dangerous fraud of impregnating wines with Litharge: If the Wine, on being mixed with the ſolution of Auripigment, acquires a browniſh red or a blackiſh colour, we may be ſure it has ſuffered that abuſe. The production of the colour in theſe experiments, proceeds from the ſulphureous part of the Orpiment tinging or tarniſhing the particles of Lead. Depilatory. Sympathetic Ink. Method of diſcovering Lead in Liquors.

That Orpiment contains Sulphur, appears from hence; that one part of Orpiment with half a part of Nitre and Salt of Tartar, mixed together and expoſed to the fire, flaſh and explode with great vehemence; a phænomenon never obſerved from Nitre and Salt of Tartar without Sulphur. Agricola ſurely never tried the proceſs which he directs in his notes on Poppius, of ſubliming this fulminating compoſition in a glaſs body for the ſpace of ten hours: If ſuch a proceſs was attempted, the veſſels would ſoon be burſt in pieces, to the hazard of the operator's life. A mixture of Orpiment and Nitre, injected into a red-hot crucible, deflagrates with a bright flame, in the ſame manner as a mixture of Sulphur and Nitre: Some white arſenical flowers ariſe, and the remainder Compoſed of Sulphur and Arſenic.

ORPIMENT. mainder is a fixed Arſenic. It were needleſs to bring more evidences of Orpiment containing Sulphur, when the fine Cinnabar parable from Orpiment and Mercury-ſublimate is of itſelf an inconteſtable proof.

That this mineral contains Arſenic, appears from the arſenical flowers which it yields in the fire, and the fixt Arſenic which remains upon deflagrating it with Nitre: This reſiduum whitens Copper in the ſame manner as common fixt Arſenic. Arſenic melted with alcaline Salt and Sope or other fat matters, yields a ſparkling Regulus; and Orpiment, treated in the ſame manner, affords a Regulus agreeing in all reſpects with the other. The Alcali abſorbing the Sulphur of the Orpiment, forms with it a hepar Sulphuris; which diſſolves in water, and on the addition of Vinegar depoſites a ſulphureous Precipitate, in the ſame manner as the antimonial ſcoria. The following experiment puts this affair beyond diſpute. If equal parts of Orpiment and Sope be well mixed together, the mixture put into a glaſs retort, and the fire gradually raiſed; at firſt, a whitiſh, unctuous, ſulphureous liquor ariſes; next a portion of the Sulphur of the Orpiment ſublimes into the neck of the retort, partly tinged blackiſh by the Oil of the Sope, and partly appearing yellow and reddiſh; at laſt, in a red heat, a ſparkling Regulus, the ſame with Regulus of Arſenic, ſublimes: A ſmall portion of the Sulphur of the Orpiment remains behind, detained by the Alcali of the Sope. The ſulphureous Sublimate participates of the arſenical matter of the Orpiment, and hence diſcovers a poiſonous quality, though in a far leſs degree than the Regulus, or the white flowers of Orpiment.

Regulus of Arſenic.

Products from Orpiment, with Sublimate.

Half a pound of Orpiment, and a pound of Mercury-ſublimate, were well mixed together, put into a wide-necked glaſs retort, and ſuffered to ſtand for a day and night in a cellar; a large receiver being then adapted and cloſely luted, a gentle fire applied and increaſed by degrees; there ariſes a conſiderable quantity of a ſmoking ſpirit, clear and tranſparent as water, called butter of Arſenic or of Orpiment: This is followed by an oily liquor, which like vegetable oils, ſwims upon the ſpirit, and if an hundred times forced under it, ſtill riſes to the ſurface again: On further increaſing the fire, a conſiderable proportion of Cinnabar ſublimes; and there remains, in the bottom of the retort, a little yellow, light, crumbly matter, which is the earth of the Orpiment. There aroſe alſo a little arſenicated Sulphur, not ſaturated with the Mercury, of a red colour, reſembling a ruby. Some direct, for this proceſs, equal parts of the Orpiment and Mercury-ſublimate; but unleſs the Sublimate is taken in a larger quantity, its acid will be inſufficient to diſſolve and elevate the Arſenic, and its Mercury inſufficient to form a true Cinnabar with the Sulphur. The ſame thing happens in this operation, as in making the butter of Antimony: The marine acid of the Sublimate quits the Mercury, to unite with the arſenical Regulus with which it has a greater affinity; whilſt the Mercury of the Sublimate unites with the Sulphur of the Orpiment, The greater fluidity of the butter of Orpiment than of the butter of Antimony depends on the different qualities of their metallic part; the Regulus of Orpiment being more ſubtile, fuſible, volatile, of greater activity upon metallic bodies, than the Regulus of Antimony. The butter of Orpiment, dropt into water, depoſites a white powder in the ſame manner as butter of Antimony does: This powder, edulcorated,

rated, and ſet to ſublime in a Silver box cloſely luted, corrodes the Silver, ſo as to render it in part ſpongy like a Pumice. Cobalt, Biſmuth-ore, and the red Silver-ore, which are all arſenical, have the ſame effect upon Silver. If the butter or Spirit of Orpiment be mixed with Spirit of Nitre, and ſet to diſtil, the phænomena are the ſame as when butter of Antimony is treated with that acid: A powder which is no other than fixed Arſenic, remains; and an Aqua regia ariſes, impregnated with a part of the Arſenic, ſo as to render Gold white; whence ſome have been induced to believe, that the tinging matter of Gold was extracted by this menſtruum. ORPIMENT.

With regard to the oil it has been ſuppoſed by ſome not to proceed from the Orpiment, and to be no other than a ſolution of a part of the Mercury-ſublimate: But the ſame kind of liquor is obtainable, without the addition of any Mercury-ſublimate, from Orpiment and common Salt, with a ſuitable quantity of Oil of Vitriol to extricate the acid of the Salt: Arſenic treated in the ſame manner yields no ſuch oil. This oil, dropt into water, renders the liquor turbid. On the addition of Oil of Vitriol, it coagulates, and a kind of ſlimy matter ſubſides: If water be now poured in, a white oil appears at the bottom, which on ſtanding diſſolves into a clear liquor: If the liquor be then evaporated, it becomes brown, is difficultly brought to dryneſs, and depoſites a ſaline ſediment. The oil, mixed with Aqua regia, ſettles alſo to the bottom. With ſtrong Spirit of Nitre, it does the ſame; but on digeſtion it is diſſolved: The liquor becomes brown in evaporation, and is difficultly exſiccated, but yields no ſediment; diluted afreſh with water, it appears yellow. Alcalies, both fixed and volatile, added to the oil, occaſion a precipitation.

Spirit of Salt poured upon Orpiment in powder, makes a ſlight efferveſcence, but no ſolution or change enſues; the ſulphureous part of the mineral defending the metallic from the action of the acid. Orpiment being mixed with Aqua fortis into the conſiſtence of a paſte, an efferveſcence begins after ſtanding about half an hour, and nitrous vapours plentifully ariſe, till all the acid is diſſipated: The reſiduum being moiſtened afreſh with Aqua fortis, the ſame phænomena ſucceed, and the matter afterwards grows hard: Even if ten parts of the acid are employed to one of Orpiment, nitrous vapours conſtantly and copiouſly exhale. If a little of the mixture be ſet to ſhoot, ſome fine cryſtals like hairs are obtained: If the maſs be evaporated to dryneſs, it will liquefy on ſtanding in a cellar, and being then mixed with a large portion of Aqua fortis, occaſions at firſt a ſlight efferveſcence, without any further change. It is pretty remarkable, that a large quantity of Aqua fortis added at firſt to the Orpiment, has no effect. Oil of Vitriol, by coction and abſtraction from Orpiment, partly diſſolves it: The late profeſſor Schulze, at Hall, obſerves, that equal parts of Orpiment and Oil of Vitriol, ſet to diſtil in a ſtrong fire, yielded at firſt a phlegm, and afterwards a ſubſtance like an oil, ſmelling like Opium; a ſmall portion of an aſhy matter being left in the retort. When Arſenic is treated with Oil of Vitriol, there ariſes a little Sublimate reſembling plumous Alum, which deſerves further examination: See Hoffman's *Obſervationes phyſ. chem.* Aqua regia does not act upon Orpiment any more than ſpirit of Salt; except that a little of the arſenical matter may be extracted by the nitrous ſpirit in the compound acid. The Regulus, and white flowers, diſſolve more eaſily, With different acids.

ORPIMENT. eaſily, both in the nitrous and marine acid, and in compoſitions of them. Spirit of Sal ammoniac, all urinous ſpirits, diſtilled and expreſſed oils, extract from Orpiment a yellow tincture; theſe menſtrua diſſolving its ſulphureous part.

Hoffman diſtilled Orpiment with common Salt, and obtained firſt an acid phlegm, afterwards yellow flowers, and at length, in a ſtrong fire, a tranſparent red maſs, which adhered to the ſides of the glaſs. Glauber diſſolved it in the liquamen of fixed Nitre, mixed the ſolution with the ſecret Sal ammoniac, and on diſtilling the mixture, gained an acidulous and urinous phlegm, afterwards a ponderous, yellow, unctuous liquid reſembling vegetable oils, and at laſt a blood-red tranſparent Sublimate like an oriental ruby. Kunckel relates, that Orpiment diſtilled with Nitre in a tubulated retort, yields a nitrous and ſulphureous ſpirit, participating of Arſenic, with a large quantity of flowers; and that white Arſenic, with equal or thrice its weight of Nitre, injected into a red-hot tubulated retort, yields a like ſpirit, but ſtronger, and of a bluiſh colour, which diſſolves metals, and whitens Copper. Meuder informs us, that Orpiment being ſublimed with an equal quantity of Iron filings, and ten parts of the Sublimate ground on a ſtone with twelve parts of cryſtals of Silver; the mixture laid on a piece of paper, inſtantly took fire."

Pyrophorus.

Not poiſonous. This mineral, though it manifeſtly contains Arſenic, is not found to be poiſonous; the Arſenic being corrected and mitigated by the large proportion of Sulphur, in the ſame manner as the virulence of Regulus of Antimony is obtunded by that concrete: Pure white Arſenic, combined with equal its weight of Sulphur, loſes its poiſonous quality, and becomes innocent.

Depilatory. Four ounces of Quick-lime, an ounce and a half of Orpiment, an ounce of Florence orris root, half an ounce of Nitre and half an ounce of Sulphur, boiled, with a ſtrong ley drawn from the aſhes of bean ſtalks, till the matter becomes conſiſtent, then mixed with half an ounce of Oil of Spike, make the common compoſition for taking off hair; the part being afterwards anointed with Oil of Roſes. Strong Sope-leys are an equally effectual, and more ſimple depilatory. It is ſaid, that the juice of henbane prevents the growth of hair.

Uſe as a Pigment, &c. The principal uſe of Orpiment is, as a colouring drug, among the painters, book-binders, &c. Of itſelf it makes a gold-coloured Pigment; with Indigo or other blues, a green: It is commonly tempered with yolk of eggs and a little ſaffron, or with fiſh galls. At Rouen, it is uſed for ſtaining wood of the colour of boxwood. It is mixed alſo with wax, employed for heightening the colour of Gold, for hardening Lead in order to the making of ſhot, and for colouring glaſs, as may be ſeen in Kunckel's *Ars vitriaria*. Equal parts of Arſenic, Mercury, Tin and Sal ammoniac, are ſaid to afford in ſublimation a purple-coloured Pigment.

SECT.

SECT. III.

MINERAL SALTS.

THERE are two general claſſes of ſimple Salts, Acids and Alcalies. *Acids* are diſtinguiſhed by their ſour taſte; efferveſcing with and diſſolving certain earths, as the aſhes of vegetables; and changing the colour of the blue flowers of plants or their infuſions to a red. *Alcalies* are diſtinguiſhed by a pungent taſte, extremely different from ſourneſs; by their deſtroying the acidity of every kind of ſour liquor; diſſolving Sulphur by boiling; and changing the colour of blue and red flowers to a green. Liquors impregnated with one kind of Salt raiſe an efferveſcence on being mixed with thoſe of the other, greater or leſs in proportion to their ſtrength. Subſtances diſſolved in one are precipitated by the other; and in this caſe often there happens no efferveſcence upon mixture. In whatever manner they are mixed, the Acid and Alcali unite into one uniform *neutral* compound, giving no marks either of one or the other. When thus combined, in ſuch proportions as that neither may prevail, they are ſaid to be *ſaturated* with one another, or mixed to the point of *ſaturation*. This term is applied alſo to the ſolution of different ſubſtances in theſe or other liquors: Thus when a liquor has diſſolved as much of any body as it is capable of holding ſuſpended, it is ſaid to be ſaturated with that body.

SALTS. Simple Salts, acid and alcaline. Neutral Salts.

In the mineral kingdom there are three kinds of acids, naturally blended with alcalies, earths, metals or other bodies, into neutral and other ſaline concretes. The ſubjects from which theſe acids have been moſt commonly extracted are, Vitriol, Nitre, and Sea-ſalt; and hence they are diſtinguiſhed by the names of *vitriolic*, *nitrous* and *marine*. All the three are volatile in the fire, totally exhaling, when pure, in a heat below ignition; though when combined with fixed bodies, they reſiſt a much ſtronger heat, and from ſome are ſcarce to be diſunited by any degree of fire. The nitrous and marine acids are always obtained in the form of a thin liquor, the acid Salt being blended with a large proportion of water, without which it would be diffuſed into an incoercible vapour. The vitriolic ſtands in need of ſo much leſs water for its condenſation, as to aſſume commonly a thick, and in ſome circumſtances a ſolid conſiſtence. Different kinds of acids,

Alcaline Salts are of two kinds; one *fixed* in a ſtrong fire; the other *volatile* in a gentle warmth. The production of theſe from vegetables and animals will be treated of hereafter. We ſhall here only obſerve, that, volatile alcalies are very rarely met with in the mineral kingdom; but that a peculiar fixed alcali differing from thoſe of vegetables is often found in combination with the marine and vitriolic acids. and of alcalies.

CLASS

CLASS I.

Vitriolic Acid and its combinations.

VITRIOLIC ACID.

In what bodies contained.

THE vitriolic acid is diffuſed throughout the earth, the waters of the ocean, and the atmoſpherical regions; and is ſuppoſed by ſome to be the baſis of all the other acids both mineral and vegetable: Whence it is named by the chemiſts, the univerſal, primogenial, vague acid. In the mineral kingdom, it is found in great abundance; not in a ſeparate or pure ſtate, but combined with various other bodies; with the inflammable principle, into Sulphur; with certain metals, into vitriols; with mineral alcalies, into the Salt called Sal mirabile; with one kind of earth into Alum; with another, into ſelenitic concretes. Argillaceous earths, the coloured earths and ſtones, metallic ores, the ſolid bitumens, the mineral oils and waters, are all impregnated, more or leſs, with this acid or its combinations. Fixt alcaline Salts imbibe it from the air; and thus are changed in part into a neutral Salt, ſimilar on all trials to one prepared by combining the alcali directly with the common vitriolic acid.

When this acid is united with alcaline Salts either fixed or volatile, it cannot be expelled from them by any degree of fire: Nor is it ſeparable any otherwiſe, than by transferring it into ſome third body, with which it has a greater appetite of union. From ſundry earths, we can force it out by fire alone; and from the metallic bodies, with which it is naturally united into Vitriol, ſtill more eaſily, though ſcarce totally; a part of the acid being retained both by the metals and earths, after the action of a very vehement fire. It is from Vitriol, that this acid has hitherto been chiefly extracted for common uſes; whence its name *vitriolic*. When very largely diluted with water, ſo as to be but juſt ſenſibly acid, it is called *phlegm*; when leſs diluted, or more acid, *ſpirit*; and when ſo little diluted, or ſo far freed from water, as to aſſume a thick conſiſtence, *oil*, of Vitriol.

Gravity.

Fixity.

Oil of Vitriol is the moſt ponderous of all known fluids, except Quickſilver and ſome metallic ſolutions: Fahrenheit determines its ſpecific gravity to be to that of water as 18,775 to 10,000. It is conſiderably more fixed than any of the other acids; emitting no fumes or ſmell in the greateſt heat of the atmoſphere, or even in that of boiling water; and requiring, to make it boil or diſtil, a much ſtronger fire than any other ſaline liquor, a fire almoſt ſufficient to make the containing veſſel red-hot.

Imbibes moiſture from the air.

Expoſed to the air, it imbibes humidity, ſo as to acquire a notable augmentation of its weight, greater or leſs, ſooner or later, according as the ſurface of the liquor is larger or ſmaller, and the atmoſphere itſelf more or leſs moiſt. Dr. Gould, profeſſor at Oxford, relates, that three drams of Oil of Vitriol acquired, in fifty-ſeven days, an increaſe of ſix drams and a half (*m*). Hoffman

(*m*) *Dr. Gould's experiments of Oil of Vitriol imbibing moiſture from the air.*] The doctor further informs us, that the increaſe in the firſt day, was upwards of one dram; in the following days, leſs and leſs; till, on the fifty-ſixth, it ſcarce amounted to half a grain:

Hoffman abſerves, that an ounce and two ſcruples, in an open glaſs diſh, gained, in fourteen days, ſeven drams and a ſcruple. I expoſed an ounce to the air, in a low glaſs body, from September 1736 to September 1737: At the end of the twelvemonth, it weighed ſeven ounces and two drams, and thus had attracted from the air above ſix times its own weight of moiſture. VITRIOLIC ACID.

If Oil of Vitriol and water are mingled haſtily together, the mixture becomes inſtantly ſo hot as to render the veſſel inſupportable to the hand (*n*). Great caution is requiſite in mixing any kind of liquor with this acid; leſt the glaſs ſhould crack from the ſudden heat which it produces, or a part of the matter be thrown about with violence during the ebullition, to the manifeſt danger of the operator: We ſhould always add the acid, by little and little at a time to the other liquor, and never attempt to pour the latter into the former. It is obſervable, that a piece of ice, laid on the ſurface of Oil of Vitriol, ſoon melts, and when melted, flows diſtinct above the acid: If the ice and the acid are ſhaken together, they incorporate and grow hot, as when the acid is mixed with water. Raiſes heat with water and ice.

The vitriolic acid, diluted with water, ſtrongly retains a conſiderable quantity of the aqueous fluid; preventing its exhalation in a heat wherein pure water would ſoon be diſſipated; and ariſing in part along with it by a fire inſufficient to elevate the undiluted acid. The further it is diluted, the more eaſily it evaporates. Strongly retains water.

Oil of Vitriol is capable of being ſo far freed from water, as to aſſume a ſolid, butyraceous or icy conſiſtence. I have examined this point with particular care, as it has been greatly controverted, and ſeems to have been miſrepreſented by all the chemical writers; ſome affirming, that the vitriolic acid, when highly concentrated, freezes in winter, and in winter only; and others, as Stahl, that it never congeals at all, unleſs extremely diluted with water. I found, that common Oil of Vitriol continued fluid in the winter as well as in ſummer; that a more concentrated oil, which continued fluid during the ſummer, congealed in winter; and that when the acid is ſtill further freed from phlegm, it becomes conſiſtent in the hotteſt weather. Put ſome good Oil of Vitriol into a glaſs retort, diſtil off about three-fourths of it, and let the remaining fourth be cloſely ſecured from the air: The acid thus concentrated will, at any ſeaſon of the year, look like butter or ice by the time it is grown cool. A certain chemiſt thought to obtain this coagulated oil, without the trouble of diſtillation in a retort, by evaporating the more phlegmatic part of common Reduced to a ſolid ſtate.

grain: That this experiment was made in a glaſs of three inches diameter: That the ſame quantity of the acid, expoſed to the air at the ſame time, in a glaſs of only one inch, gained but one ninth ſo much as the other, which is exactly the proportion of their ſurfaces: That the liquor, when ſaturated with humidity, retained, or loſt part of its acquired weight, according as the air was moiſt or dry; and that this difference was ſo ſenſible, as to afford an accurate hygrometer *.

(*n*) *Heat from the mixture of Oil of Vitriol and water.*] About equal parts, by weight, of the two liquors, produce the greateſt heat. Hoffmann ſays in one place equal parts, in another one part of the acid to two of water †: Probably in the firſt he means by weight, in the latter by meaſure.

* *Phil. Tranſ.* N° 156. † *Hoffm. Obſ. phyſico-chem.* p. 150, 167.

VITRIOLIC ACID.

common Oil of Vitriol in an open glaſs: He complained to me, that though he had ſeen a good quantity of vapours exhale, the remaining liquor, when grown thoroughly cold, not only refuſed to coagulate, but weighed as much as at firſt. The cauſe was obvious: The Oil of Vitriol, ever greedy of humidity, had imbibed as much from the air, as it had loſt in the fire. The ſame individual liquor being put into a retort, and about one half diſtilled off; the reſiduum, excluded from the air, aſſumed now a conſiſtent form.

Quantity of Alcali it ſaturates, and of pure acid it contains.

Oil of Vitriol ſaturates a larger quantity of fixed alcaline Salt than any other acid: Five parts of this acid are ſufficient for eight or more of the alcali, whilſt the ſtrongeſt of the others is incapable of ſatiating its own weight (*o*). The acid part of the liquor being here abſorbed by the alcali, its aqueous part is ſet at liberty, ſo as to ariſe with eaſe in evaporation or diſtillation. The diſtilled fluid, though it has no manifeſt taſte, is ſaid to differ in ſome reſpects from pure water; to be more ſubtile and penetrating, and to exhale much ſooner in an equal degree of heat: It is called by Niednerus, *ſpiritus mundi* (*p*). The remaining Salt, perfectly exſiccated, diſcovers, by its increaſe of weight above that of the dry alcali employed, the quantity of ſaline matter it has received from the acid liquor, and conſequently the proportion of pure acid which that liquor contains. By this method, an ounce of good Oil of Vitriol is found to conſiſt of about five drams of acid, and three of water.

General relations to other bodies.

The vitriolic acid loſes its attraction for water, by the union of any of thoſe ſubſtances which are capable of being combined with it; even of thoſe, which, ſeparately, are as greedy of humidity as itſelf, as fixed alcaline Salts; and of thoſe by which all other acids acquire the property of attracting moiſture, as calcareous earths. It never promotes the fuſibility or volatility of bodies, as the others in many inſtances do; but on the contrary retards fuſion, and increaſes fixity. Thus vegetable fixt alcaline Salts, a powerful flux for ſundry refractory matters, and which flow eaſily when ſaturated with other acids; earths and metals, which with other acids yield compounds eaſy of fuſion; when combined with the vitriolic, cannot be made to melt at all.

Expels all other acids from alcalies and earths.

The vitriolic is the moſt powerful of all the acids; though there are many ſubſtances, which it does not act upon ſo violently, or diſſolve ſo readily, as ſome of the others do (*q*). If any other acid be combined with an alcaline Salt,

(*o*) *Alcali ſaturated by Oil of Vitriol.*] It is obſervable, that this acid does not ſaturate ſo much, by one half or more, of volatile alcaline Salts, as it does of the fixed. The nitrous acid ſeems to ſatiate a larger proportion of volatile alcalies than the vitriolic.

(*p*) *Water diſtilled from Oil of Vitriol and Salt of Tartar.*] This liquor is ſaid alſo to diſſolve leaf-gold; and when drank, even in a doſe of a ſpoonful, to excite a diaphoreſis. I have tried it with Gold, but could not obſerve that it had any action on that metal.

(*q*) *Vitriolic acid moſt powerful.*] The *powerfulneſs*, *activity*, and *ſtrength* of acids, are to be carefully diſtinguiſhed; as being three properties independent of one another, though commonly confounded together. The vitriolic is more *powerful* than any of the others, as it expels them all from alcaline Salts both fixed and volatile, and from the ſoluble earths; and takes poſſeſſion itſelf of the Alcali or earth. It is leſs *active*, or acts more languidly and difficultly, upon moſt bodies, than either the nitrous or marine. In its concentrated ſtate, it is the *ſtrongeſt* of acids, as containing the largeſt quantity

Salt, the addition of the vitriolic will take the alcali from it: The acid before combined, though it could not be expelled by fire alone, will now readily exhale, and leave the vitriolic in poſſeſſion of the alcali. On this principle depends the diſtillation of the acid ſpirits of Nitre and Sea-ſalt. Hence alſo we are furniſhed with a method of diſcovering which of the mineral acids any compound Salt contains: Oil of Vitriol has no action on thoſe, which hold no other acid than the vitriolic itſelf, but effervesces with the others, and immediately extricates a part of the acid in vapours: The particular acid may be diſtinguiſhed by the colour and ſmell of the fumes. VITRIOLIC ACID.

The vitriolic acid retards fermentation and putrefaction; but has this effect in a leſs degree than the other acids, whether employed in its pure ſtate, or combined with other bodies: How little it is diſpoſed to prevent putrefaction when united with certain metals, appears from the mouldineſs to which common ink is ſubject. How it influences fermentation and putrefaction.

Hoffman obſerves, that the concentrated acid, or Oil of Vitriol, applied ſlightly and ſuperficially to the ſkin of a living animal, raiſes a violent burning heat and pain; but that a larger quantity, preſſed cloſe on the part, ſo as to prevent the ingreſs of the aereal moiſture, occaſions little pain or eroſion: If the oil is diluted with a little water, it proves corroſive in either caſe. Applied to the human body.

The vitriolic acid, largely diluted with water, is employed medicinally for preventing a putrefactive diſpoſition, correcting bilious acrimony, abating heat, quenching thirſt; in debilities of the ſtomach, and in the heartburn. To perſons of weak or unſound lungs, to women who give ſuck, to hydropic and emaciated perſons, it is injurious. Some recommend it as a collyrium for ſore eyes; but as it coagulates the animal juices, and corrodes and indurates the ſolids, it is ſurely very unfit for being applied to that tender organ. Medical uſes.

ARTICLE I.

Combination of the vitriolic acid with inflammable matter.

OIL of Vitriol, however limpid and clear, becomes yellowiſh, brown, reddiſh, black, from the bare contact of any inflammable matter, as a ſmall bit of cork, paper, wax, bladder, or other like ſubſtances, which give no conſiderable tincture to any liquor beſides: The whiteſt camphor and ſugar, the moſt limpid eſſential oils and diſtilled inflammable ſpirits, have the ſame effect. It is obſervable that ſome ſubſtances, as Camphor and Oil of Turpentine, give a colour to the acid only in its concentrated ſtate; and that the colour produced diſappears again upon diluting the liquor. Camphor put into Oil of Vitriol, is diſſolved by it, loſes its own ſtrong penetrating ſmell, and renders the liquor black like pitch: On adding a quantity of water to the pitchy Becomes coloured from the contact of inflammable ſubſtances.

quantity of pure acid in proportion to the phlegm or water. However *weakened* by dilution, it ſtill continues the moſt *powerful*: By thus *weakening* it, its *activity* is oftentimes *increaſed*. Vegetable acids may be made *ſtronger* than the marine, but ſtill continue *leſs powerful*, as being expelled by it from alcalies and earths.

VITRIOLIC ACID.

pitchy mixt, the Camphor inſtantly recovers its odour, and the acid its colourleſs pellucidity.

Phænomena with vinous ſpirits.

Oil of Vitriol, dropt into eight times its weight or more of highly rectified Spirit of Wine, by a little at a time to prevent any immoderate ebullition or diſcharge of vapours, forms with it on digeſtion for ſome days, a reddiſh liquor; which being committed to diſtillation, great part of the acid ariſes along with the vinous ſpirit by a very gentle heat; an acid, bituminous, ſulphureous matter remaining. The diſtilled liquor, impregnated with the volatilized Oil of Vitriol, has a fragrant ſmell, and diſcovers no acidity to the taſte; and hence is called *dulcified Spirit of Vitriol:* In length of time, however, its fragrance diminiſhes, and the latent acid begins to reſume its acidity.

With oils.

Oil of Vitriol, mixed with diſtilled oils, occaſions great heat, efferveſcence, and ſulphureous fumes; and unites with the oil into a dark coloured maſs, like Pitch or Bitumen, from which a portion of Sulphur is producible. On expreſſed oils, it acts much leſs violently than on the diſtilled. An account of its particular effects on different oils may be ſeen in Hoffman's *Obſervationes Chemicæ.*

Volatilized.

In the extraction of the vitriolic acid from Vitriol or other fixed bodies by vehemence of heat; if the diſtilling veſſel had any fiſſure, or contracted any in the fire, the acid receives a remarkable alteration. It now proves extremely volatile; emitting pungent and almoſt ſuffocating vapours in the air, and totally ariſing in diſtillation by a heat ſcarce too great for the hand to bear. It is ſo much leſs corroſive than the acid in its fixed ſtate, as to be ſafely taſted; when it diſcovers only a ſlight biting bitteriſhneſs and roughneſs, with ſcarce any ſenſible acidity. It neutralizes fixed alcaline Salts; but inſtead of expelling, it is itſelf expelled from them by both the other mineral acids (*r*). This volatile ſpirit, kept for ſome time in a veſſel not cloſely ſtopt, loſes its ſuffocating odour, reſumes its fixity, acidity, and all its former qualities.

Production of Sulphur.

The vitriolic acid, freed from phlegm, and combined by fire with a due proportion of any inflammable matter, is changed into a ſolid, inſipid concrete *Sulphur.* Thus when the concentrated acid is mixed with oils, and the phlegmatic part drawn off, a true Sulphur may be ſublimed from the reſiduum. If the acid be ſaturated with an alcaline Salt, as the alcali of Sea ſalt with which it forms a fuſible compound, the aqueous part of the mixture evaporated, and the remaining Salt (called *Sal mirabile*) melted with ſome powdered charcoal; the reſult will be, not a combination of the Alcali and vitriolic acid as at firſt, but of Alcali and Sulphur; from which the Sulphur is eaſily ſeparable by ſolution in water, and precipitation with any acid.

(*r*) *Volatile Spirit of Vitriol.*] This ſpirit, though it ſcarce diſcovers any acidity to the taſte, raiſes a conſiderable efferveſcence with alcaline Salts both fixed and volatile, and ſaturates a large proportion of them: It inſtantly loſes its pungent odour on the admixture of the Alcali: The mixture ſhoots into ſmall cryſtals, which, on the affuſion of any other acid, yield up the vitriolic again, as volatile and ſuffocating as it was received. This ſpirit deſtroys or whitens the blue and red colours of the flowers of plants; whilſt in its fixed ſtate, like other acids, it changes the blue to red, and heightens thoſe which were naturally of that colour.

SULPHUR *or* BRIMSTONE.

THE name Sulphur has been applied by ſome to the inflammable principle of bodies; by others, to all inflammable mixts, or ſubſtances participating of this principle; and the alchemiſts ſpeak alſo of a Sulphur that does not burn. Vegetable oils and reſins, animal fats, mineral bitumens, are by ſome called Sulphurs; and by ſome, Sulphur itſelf is referred to the bitumens. This confuſion has given riſe to numerous errors and abſurdities: How widely different is true Sulphur, in all its properties, from bitumens, or oils, or any other kind of inflammable body! If every thing that burns was to be called Sulphur, we might with equal propriety call every thing that is liquid by the name of water, or of ſpirit of wine, or vinegar, or oil, or any other particular liquor. Experiment has fully evinced, that Sulphur is no other than the concentrated vitriolic acid combined with a ſmall proportion of the phlogiſtic or inflammable principle; and to this combination alone, which is always one and the ſame excepting for adventitious admixtures, the more judicious chemiſts have wholly confined the name.

General properties.

Sulphur is a ſolid brittle concrete, of a yellow colour inclining a little to greeniſh, in ſome degree gloſſy. Held in the warm hand, it crackles, or burſts: and leaves on the hand a particular kind of ſmell. It is nearly twice as heavy as an equal bulk of water.

Fuſion.

It melts in a ſmall degree of heat into a red pellucid fluid, and on cooling concretes again into its original appearance. Some have endeavoured to purify Sulphur from the droſſy matters which are often mixed with it, by melting and pouring it into Spirit of Wine: Others have melted it with wax, and poured the fluid mixture into water, when the Sulphur ſubſides, and the wax ariſes to the ſurface, carrying up with it a part of the impurities. With regard to Spirit of Wine, it can have no effect in ſeparating foreign matters from the Sulphur, though it ſeems in ſome meaſure to heighten the yellow colour. Wax on the other hand renders it greener, and if the fuſion is ſeveral times repeated, changes it quite blackiſh.

Sublimation.

Sulphur kept in fuſion, gradually exhales: If the air is excluded, it ſublimes into the upper part of the veſſel, without undergoing any other alteration, than being reduced into the form of powder or flowers. This property affords a method of purifying it effectually from earthy, ſtony, or other fixed matters; and at the ſame time of reducing it into a finer powder than can eaſily be obtained by trituration. Where only a ſmall quantity of flowers of Sulphur is wanted, the ſublimation may be performed in a jar, with aludels cloſely luted upon it, and a blind-head at top. In England, they are prepared by particular perſons in the way of trade: The ſubliming veſſel is an Iron pot, ſo large as to hold two or three hundred weight or more of Sulphur, about a fourth of its capacity remaining empty: The recipient is an arched room built above the pot, and communicating with it at one ſide by an aperture of ſix or eight or more inches in diameter. The room is lined with glazed tiles; and furniſhed with a door, by which a man may creep in, when the operation is finiſhed, to ſweep out the flowers. In the middle of the door is a ſmall hole,

which

SULPHUR. which is opened occaſionally during the ſublimation, for examining whether the flowers continue or have ceaſed to ariſe.

Acid ſpirit. In open veſſels, Sulphur readily takes fire from the contact of ignited bodies, and if kept in fuſion, burns entirely away, with a blue flame, and a diffuſive ſuffocating fume (*s*). This fume is no other than the vitriolic acid volatilized by the flame: A conſiderable quantity of it may be detained, and condenſed into a liquid form, by placing over the burning Sulphur capacious glaſs veſſels, replete with aqueous vapours: The larger the receivers, and the leſs communication the flame has with the external air, the more of the fumes will be preſerved.

Methods of collecting the acid. The moſt common apparatus for this purpoſe conſiſts of a little earthen diſh, for burning the Sulphur in; a glaſs bell, ſuſpended over the flame; and a broad glaſs or earthen veſſel, which ſupports the diſh with the Sulphur, and receives the acid liquor as it drops from the ſides of the bell. Many variations have been made in this apparatus, with a view to detain the fumes more effectually. Inſtead of the bell (from which the acid has received the name of *Spiritus ſulphuris per campanam*) ſome have employed a glaſs differing from that ſhape in having a rim turned in at the bottom, and a tube at the top, to which a receiver is fitted as an enlargement of the capacity of the veſſel; others a retort, with its bottom cut out, and a glaſs body or tubulated receiver applied to its neck; others a receiver, with a hole in its bottom for admitting the flame; others a glaſs body, with ſome water in its bottom, holes in the ſides, a crucible with burning Sulphur placed in the water, and another body inverted on the mouth: Some have ſuſpended the burning Sulphur in a wooden caſk half full of water, and afterwards rectified the liquor. The grand difficulty is, that Sulphur will not burn without a draught of air, and the acid fumes are ſo volatile that far the greateſt part of them is carried off by the air. Some direct a little Nitre to be mixed with the Sulphur, to promote its burning; but though Nitre is undoubtedly of advantage in that reſpect, it is injurious in another; rendering the product impure, by giving out its own acid along with that of the Sulphur. Many other contrivances have been made, but none with any commendable ſucceſs; the ſame acid being obtainable at a much cheaper rate from Vitriol, than by any of the methods of procedure to which Sulphur has hitherto been ſubmitted (*t*). The beſt way hitherto diſcovered of collecting

(*s*) *Inflammability of Sulphur.*] Stahl obſerves, that an ounce of Sulphur, burnt with a wick, may be made to yield a conſtant flame, for ſix hours; and that, when the wick was very ſmall, only fifteen or ſixteen grains were conſumed in an hour. See *Stahlii exp.* CCC *numero chymicæ & phyſicæ.*

(*t*) *Method of collecting the acid of Sulphur.*] This proceſs has of late been ſo far improved, by ſome particular perſons, as to furniſh, at a very low price, almoſt all the acid now ſold under the name of Oil of Vitriol. The improvement conſiſts, in employing very large glaſs veſſels of the capacity of a hogſhead or more, in which is placed a little water, whoſe ſteam collects and condenſes the fumes; but principally in mixing with the Sulphur a ſmall portion of Nitre, about ſix pounds to an hundred weight, which enables it to burn much more ſpeedily than Sulphur by itſelf, and without communication with the external air: By this means nearly all the fumes are preſerved. It does not appear, that the ſpirit thus collected contains any of the nitrous acid; for the acid of Nitre is deſtroyed by deflagration. See *Nitre.*

collecting the acid ſpirit of Sulphur in a volatile ſtate, is that given by Stahl: The Sulphur is made to burn ſlowly by means of a wick, a number of aludels ſet over it, and a cloth moiſtened with ſtrong alcaline ley placed in each aludel: As ſoon as any of the clothes become dry, a moiſt one is put in its room. The alcaline Salt which the clothes were impregnated with, imbibes the acid fumes, and is thus converted into a neutral Salt, which is eaſily rubbed out. It is the volatile vitriolic acid that this Salt contains; and hence, upon adding to it common Oil of Vitriol, in a tubulated retort, the volatile ſpirit diſtils, leaving the Alcali combined with the more powerful fixed acid ſuperadded. The volatile however, as well as the fixed acid, is ſtill more commodiouſly and advantageouſly obtainable from Vitriol itſelf. SULPHUR.

It was formerly ſuppoſed, that the acid ſpirits of Vitriol and Sulphur were really different from one another, and hence they were received in the ſhops as two diſtinct acids: Their identity is evident from hence; that the ſpirit obtained from common Sulphur, united with metals, forms a true Vitriol; and the ſpirit extracted from common Vitriol forms, with inflammable ſubſtances, a perfect Sulphur, not diſtinguiſhable on any trial from pure mineral Brimſtone. We ſhall ſee hereafter, that common Vitriol is a production from ſulphureous minerals; and that the acid of the Vitriol is the very individual acid, which before entered the compoſition of the Sulphur. Its acid the ſame with that of Vitriol.

Sulphur does not diſſolve in water, in Spirit of Wine, or in acid liquors: The vitriolic acid, nevertheleſs, extracts a part of the acid of the Sulphur, ſo as to gain a conſiderable increaſe of its own acidity (*u*). Fixed alcaline Salts, injected upon half their weight or leſs of melted Sulphur, readily unite with it into a red or liver-coloured maſs, called *hepar ſulphuris*, which deliquiates in the air, diſſolves in water, and gives a golden tincture to Spirit of Wine: The watery ſolution, kept for ſome time, generally depoſites a black powder: Sulphur is diſſolved alſo by boiling in fixt alcaline Lixivia, or in Lime-water. The addition of any acid to theſe ſolutions, renders them milky, and precipitates the Sulphur in form of a white powder called *lac ſulphuris:* During the precipitation, an extremely fetid vapour ariſes, which blackens metalline utenſils, particularly ſilver ones, at a conſiderable diſtance (*x*). Menſtrua of Sulphur.

If the mixture of Sulphur and fixed alcaline Salt, be reduced to powder, kept for ſome time in a gentle heat, and frequently ſtirred; the Sulphur will be deſtroyed, or reſolved into its conſtituent parts. The inflammable principle is gradually diſſipated, and only the acid of the Sulphur remains combined Reſolution of Sulphur by fixed alcalies.

(*u*) *Effect of menſtrua*, &c.] Sulphur, repeatedly melted and quenched in water, aſſumes a degree of tranſparency, but of ſhort duration. By treating it in the ſame manner with Spirit of Wine, its yellow colour, as formerly obſerved, is ſomewhat improved. The marine acid, long boiled on Sulphur or repeatedly abſtracted from Sulphur, is ſaid to render it conſiderably tranſparent; the vitriolic, to make it leſs inflammable, and more fixed in the fire; the nitrous, to occaſion no change.

(*x*) *Precipitation from alcalies and Lime.*] The Precipitate, though of a white colour, does not ſeem to differ in quality from what the Sulphur was at firſt, provided it has been carefully waſhed from the adhering ſaline matter: On ſublimation, or ſimple fuſion, it reſumes its original yellow colour. It is obſervable, that fixed alcaline Salts precipitate Sulphur from the ſolution made by Quick-lime; and that the fetid ſmell, ſo ſtrong in all the precipitations of Sulphur by acids, is not here perceivable.

SULPHUR.

bined with the Alcali. Instead of a red, fetid, alcaline, sulphureous compound, we find now a white, inodorous, neutral Salt, the same as if common Oil of Vitriol had been mixed with the Alcali. From this experiment we are enabled to determine the proportions of acid and phlogiston of which Sulphur consists; the increase of weight which the alcaline Salt acquires being pure concentrated acid. It appears upon careful trial, that in sixteen ounces of Sulphur, there are upwards of fifteen ounces and six drams of pure vitriolic acid void of phlegm; the inflammable matter, by which so large a quantity of that most corrosive acid is in all its properties so surprizingly changed, amounting only to about a dram.

Proportions of acid and phlogiston.

Some report that Sulphur will dissolve in volatile alcaline spirits, without any intermedium. Boerhaave directs, for this purpose, any strong alcaline spirit to be distilled from flowers of Sulphur, and cohobated or drawn over a second time from the residuum; or the mixture to be long kept in a close vessel, and frequently shaken. I tried strong spirits of Sal ammoniac, both simple and dulcified, prepared both with alcaline Salt and with Quick-lime, and a spirit saturated with Oil of Aniseeds: But none of the five made any solution, or extracted any tincture from the Sulphur, either by digestion or distillation.

Solution in volatile spirits.

There are means, however, of procuring a perfect solution of Sulphur in volatile spirits; namely, by mixing the Sulphur, not with the spirit already prepared, but with crude Sal ammoniac; and adding Quick-lime to extricate the volatile Alcali, which thus will elevate with it in distillation a considerable portion of the Sulphur. Beguinus takes four parts of Sulphur, two of Quick-lime, and one of Sal ammoniac: Hoffmann's proportions, three parts of Lime, two of Sal ammoniac, and one of Sulphur, succeeded better with me. The mixture is to be put into a retort, and distilled by a gradual fire, the juncture of the retort with the receiver being closely luted. The distilled liquor called sulphureous Spirit of Sal ammoniac, smoking Spirit of Sulphur, or volatile Tincture of Sulphur, is extremely volatile and penetrating, emits highly fetid vapours, which blacken Silver, and give colour to invisible writings made with saturnine solutions, like the liquor of Orpiment, page 155. It is employed medicinally in some compositions; internally as a sudorific, and externally as an antipodagric.

Solution in oils:

Various balsams.

Sulphur dissolves in oils, by the assistance of a boiling heat, into a thick, yellowish or reddish fluid, called Balsam or oily liver of Sulphur. This process should be performed without doors, in large vessels; the matter constantly watched and stirred, and, if it begins to rise up, removed immediately from the fire: Otherwise the combustible compound will suddenly run over into the furnace, and may be productive of terrible consequences: One of my people very narrowly escaped from such an accident with his life, and will carry the effects of it to his grave.

Expressed oils dissolve Sulphur far more readily and plentifully than the distilled. The balsams of Sulphur with distilled oils, directed in books of pharmacy, are very injudicious preparations; as the oil will scarcely gain any tincture from the Sulphur, without a boiling heat; and such a heat will destroy the flavour and peculiar qualities of the oil. If these kinds of preparations are wanted, they may be much more commodiously and advantageously obtained

obtained by adding a due proportion of any eſſential oil to the ſolution made with expreſſed ones. Expreſſed oils will eaſily take up half their weight of Sulphur, and form with it, when grown cold, a thick conſiſtent maſs: If this be liquefied by a gentle heat, and any eſſential oil added, they will readily incorporate together. The eſſential oil of Aniſeed differs remarkably from all the other diſtilled oils, in its power of diſſolving Sulphur; taking up rather more even than the expreſſed. This oil, digeſted with the *hepar ſulphuris*, or compoſitions of Sulphur and fixed alcaline Salts, readily takes up a large quantity of Sulphur from the Alcali: Other eſſential oils abſorb very little; and expreſſed ones ſcarce any at all. It is obſervable that the balſam of Sulphur with oil of Turpentine, if ſaturated with the Sulphur whilſt hot, concretes on cooling into a curious vegetation reſembling a tree. SULPHUR.

Sulphur unites in the fire with moſt metallic bodies, promotes the fuſion of the refractory ones Iron and Copper, renders Lead on the other hand almoſt unfuſible, and debaſes the quality of them all. It changes ſeveral into the appearance of their own ores; Silver, into a ſoft leaden coloured ſubſtance, reſembling the malleable ſilver ore; Iron and Copper into yellowiſh concretes, like the natural Pyritæ; the antimonial Regulus into Antimony; Quickſilver and Arſenic into red compounds, the ſame with the native Cinnabar and red Arſenic; Lead, into a dark-coloured maſs, like its common ore; Tin, into a ſubſtance like Antimony, a form in which that metal is never found in the earth. Pure Sulphur does not act upon Gold, but ſulphurated Alcali or *hepar ſulphuris* unites with Gold in fuſion as well as with other metals, and renders it diſſoluble in water ſo as to paſs through the pores of a filter (*y*). Effects of Sulphur on metals. Artificial ores.

The

(*y*) *Effects of Sulphur on metals.*] It unites with all the metals and ſemimetals, except Gold, Platina, and Zinc; but ſcarcely acts upon metallic calces, excepting thoſe of Lead and Nickel. It promotes the fuſion of Iron, Copper, Silver, and Regulus of Antimony; and impedes that of Lead, Biſmuth and Tin, particularly of the former.

Though Sulphur is, by itſelf, very volatile in the fire, it adheres ſo ſtrongly to metallic ſubſtances, as not to be eaſily expelled. It is not diſſipable from any metal in cloſe veſſels: In open ones, it may be entirely diſſipated from Silver, Tin, Biſmuth, and Regulus of Antimony; the firſt of which it leaves uninjured, or in its perfect metallic form; the others in that of a calx. To Copper of all metals it adheres the moſt ſtrongly; and hence the difficulty of extracting pure Copper from its ſulphureous ores. The acids which diſſolve metals by themſelves, and oils and alcaline liquors, which diſſolve Sulphur, do not, unleſs in a few inſtances, effectually extract either when combined with the other; the one defending the other from the action of its appropriated menſtrua.

Different metallic bodies have different degrees of affinity or attraction to Sulphur, Arſenic the leaſt. When Sulphur is combined with Arſenic, it will part with the Arſenic on adding Quickſilver; with which laſt it remains united at the bottom of the veſſel, whilſt the Arſenic, more volatile than that compound, ſublimes pure. If Regulus of Antimony is joined to the ſulphurated Mercury, the Quickſilver is ſet at liberty, and diſtils by itſelf, leaving the Sulphur behind in poſſeſſion of the Regulus. Silver abſorbs it from that ſemimetal, forming with the Sulphur a kind of ſcoria, which flows diſtinct upon the ſurface. In like manner, Biſmuth takes it up from the Silver; Tin from Biſmuth; Lead from Tin; Copper from Lead; and Iron from all the foregoing: Hence the uſe of iron filings in the aſſaying and ſmelting of ſulphureous ores.

SULPHUR. The principal uſe of Sulphur is in fire-works, and for making gunpowder.

Gunpowder. The diſcovery of gunpowder is attributed by ſome to an Engliſh monk, Roger Bacon; by others to a monk of Freyberg, Berthold Schwartz, about the year 1380: Whoever was the inventor, the diſcovery was doubtleſs accidental; for who could have expected, from any artificial compoſition, the aſtoniſhing effects of gunpowder. The ingredients are Nitre, Charcoal and Sulphur, the proportions of which are different in different works, and generally kept a ſecret. The Sulphur is commonly in ſmalleſt quantity, and the Nitre in the largeſt: Some take but one part of Sulphur to ſeven of Nitre: Others three or four of Nitre to one of Sulphur and one of Charcoal: Others two parts of coals to one of Sulphur. There are differences alſo in the choice of the Charcoal, and the Sulphur, and the purification of the Nitre. Among us, the powder made at Liſſa in Poland has been always accounted the beſt. Lemery ſays the Sulphur ſhould be previouſly freed from a part of its fixed alcaline Salt: Sulphur has nothing of any ſuch Salt to loſe, but it would be proper, if it would anſwer in point of expence, to ſeparate the earthy impurities by ſublimation. It is not the Sulphur in the compound that firſt takes fire, as the above-mentioned author imagines, but the Charcoal: I mixed Sulphur and Nitre in ſixteen different proportions, but none of the mixtures would take fire from a ſpark, without the addition of ſome animal or vegetable inflammable matter——Sulphur is employed likewiſe in ſome woollen manufactures, in bleaching, for making Cinnabar, by the wine-coopers, for ſundry œconomical and other like purpoſes——It is uſed medicinally againſt cutaneous eruptions, and diſorders of the lungs: From the virtues attributed to it in this laſt intention, it has received the name of *anima pulmonum*.

Medical uſe.

Natural hiſtory. Sulphur is ſometimes found native in the earth, in pure, bright yellow, ſemitranſparent maſſes; but more commonly in opake ones, of a greeniſh, greyiſh, or other colours, intermixed with various earthy or ſtony matters: Theſe impure ſorts are thoſe commonly underſtood by the name of *Sulphur vivum*. The native Sulphurs are met with chiefly about Volcanos in Italy, in ſome of the German, Hungarian, and Swediſh mines. A pale yellow tranſparent Sulphur is brought from Guadaloupe in America, and called by the French *Soufre de Guadaloupe*, *de guido*, or *de quittau*. Monardus mentions a *Sulphur vivum præſtantiſſimum* as he calls it, tranſparent as Glaſs, and in colour like Gold.

Red Sulphur. There are likewiſe reddiſh, and red Sulphurs; of which I have ſeen ſome of a ſemitranſparent cinnabarine red: Theſe are never to be employed for medicinal uſe, as they are rarely free from an admixture of Arſenic, and indeed are rather to be looked upon as a native red Arſenic or Realgar, than as Sulphurs: The redder the colour, the more Arſenic they generally hold (z). The greateſt

Fixed alcaline Salts abſorb Sulphur in fuſion from all the metals; but as ſoon as they have taken up the Sulphur, the compound which they form with it begins to redilſolve the metal. This compound acts more powerfully on metals than Sulphur by itſelf, entirely deſtroys their metallic aſpect, and renders moſt of them ſoluble in water. Zinc is the only metallic ſubſtance which reſiſts this compoſition.

(z) *Arſenicated Sulphur.*] Here it may be obſerved,

greateſt quantities of theſe red arſenical Sulphurs are found in the Turkiſh dominions; and ſome in the territories of Saltzburg. SULPHUR.

Authors mention another ſort of native Sulphur, which ſeparates from the hot mineral waters, particularly thoſe of Aix-la-chapelle: Whether this yellow ſediment be a true Sulphur or not, I cannot determine, as I have not had an opportunity of examining it.

Sulphur is an ingredient in moſt kinds of ores, and frequently is the only one by which metallic bodies are debaſed in the earth into that form. Tin, Biſmuth, and Cobalt are the only ones which have no Sulphur in their ores: Arſenic and Gold are frequently accompanied with it: Silver, a good deal more frequently; and Lead ſtill more ſo: Of Copper, it is a more conſtant attendant than of any of the foregoing: Mercury and Regulus of Antimony are never found without it. The common ores of Iron rarely hold any Sulphur: The mineral, however, which contains the largeſt quantity of Sulphur, or from which the Sulphur is extracted to the greateſt advantage, is a ferruginous ore, called, from its colour, and from its ſtriking fire with Steel, *yellow Pyrites*. Sulphur in ores.

The yellow *Pyritæ* are found moſt plentifully in ſome parts of Sweden, and in Saxony, where the principal Sulphur works are eſtabliſhed. The Sulphur is extracted in ſome places, by diſtillation in large Iron retorts: In others, by eliquation in earthen veſſels; the Sulphur, as it melts out from the ore, being conveyed along inclined pipes into veſſels of cold water. At Goſlar in the lower Saxony, great quantities of Sulphur are collected in the calcination of certain ores in the open air: The ore being ſtratified with wood, and the wood ſet on fire, the Sulphur melts out in different parts of the pile, and is received in veſſels placed underneath, or in cavities made for that purpoſe in the matter itſelf when ſoftened by the heat: The rough Sulphur obtained by theſe proceſſes is purified by fuſion; which is ſometimes twice or thrice repeated: The lighter feculencies, which ariſe to the ſurface, are ſkimmed off; and the fluid Sulphur poured from the groſſer ſediment that falls to the bottom. Moſt of the Sulphur prepared in Germany appears of a fine yellow colour, or inclines but a little to greeniſh yellow: The Swediſh, particularly that which comes from the iſland Melo, has more of the green, and is not near ſo fine. The impure Sulphur, or dregs remaining after the purification, are called *Sulphur caballinum*, as being only fit for horſes: But even for ſuch purpoſes, it is ſurely more adviſable to uſe pure Sulphur, than an unequal and an unknown mineral medley, which may often do more harm than good. Method of extracting.

Hoffman

obſerved, that moſt ſorts of native Sulphur participate of Arſenic; though the quantity of Arſenic is commonly too ſmall to be diſcoverable by any reddiſh or orange caſt, till a part of the Sulphur has been exhaled by fire or detained by additions. This obſervation is to be particularly attended to in peruſing the writings of the ancient chemiſts, who frequently direct Sulphur to be ſublimed repeatedly from iron filings or other matters, till it becomes *red and tranſparent like a ruby*; an effect in vain expected from the pure Sulphur we are now ſupplied with, but which readily ſucceeds with the arſenicated mineral ſorts which were then made uſe of.

SULPHUR. Hoffman and others have presumed, that Sulphur exists in the air, and that from this proceed thunder, lightning, and other fiery meteors; the vitriolic acid and inflammable principle, the very ingredients from which art produces Sulphur, being unquestionably diffused through the atmosphere. Plausible as this theory may appear, it is liable to considerable objections: Art cannot produce Sulphur without a degree of fire, which we cannot suppose to have any place in the atmosphere: No Sulphur can be generated but with the concentrated acid, and how infinitely, on the other hand, is the aereal acid divided and diluted! Besides, the effects of Sulphur and of lightning are in nowise similar.

Whether contained in the air.

ARTICLE II.

Combination of the vitriolic acid with metallic bodies.

VITRIOLS. THE vitriolic acid, in its diluted state, and assisted by a moderate warmth, very easily dissolves Iron and Zinc; the first into a green, the other into a colourless liquor. Copper is more difficultly acted on: This metal requires the strong undiluted acid or oil, and a heat sufficient to make it boil: The more phlegmatic part of the liquor exhaling during the coction, so much of the acid remains united with the Copper, as to render it soluble in water: This solution is of a fine blue colour. Silver, Quicksilver, Tin, Lead, and Regulus of Antimony, are likewise corroded by boiling in the concentrated acid, but are not so effectually dissolved by it as the three foregoing metals. Gold is not acted upon at all by the pure vitriolic acid however concentrated or heated; though when the acid is converted into Sulphur, and then combined with fixed alcaline Salts into a Hepar, Gold is dissolved by this compound equally with the other metals.

General relation to metals.

Comparative affinity to metals. The vitriolic acid has a greater affinity with most metals than any of the other acids have. Thus, if added to a solution of Silver, for instance, made in the nitrous acid, it will attract the metal from that acid, and carry it to the bottom. This rule does not obtain universally, but the exceptions are very few: The principal exception is the strong affinity of the marine acid with the metal above-mentioned; this acid carrying down Silver from the vitriolic, as readily as the vitriolic does from the nitrous (*a*).

The

(*a*) *Affinities of the vitriolic acid with metallic substances.*] The vitriolic acid, like the others, has the greatest affinity, among metallic bodies, with Zinc, which dislodges from it all the others: The next, in degree of attraction, are Nickel, Regulus of Cobalt, and Iron; next to these Copper; and after this, Quicksilver. Like other acids also, on adding a volatile Alcali to the metallic solutions, it deposites the metal, and unites with the Alcali; and this it will again forsake for a fixed Alcali.

In some circumstances, however, this acid discovers a greater attraction to metals than to fixt alcalies themselves; and in this respect it differs from all the other acids. If fixed alcaline Salt saturated with the vitriolic acid, (that is, vitriolated Tartar) be added to a solution of Mercury or Silver; the acid instantly forsakes the Alcali, unites with the metal, dislodges it from its former solvent, and carries it to the bottom.

Hence we are furnished with a solution of the problem which Stahl some time ago proposed

The vitriolic acid discovers in general a stronger attraction to the inflammable principle than to any other known species of matter; and when combined with it, forms Sulphur. There are circumstances, however, in which it forsakes that principle, to unite with some metallic bodies, particularly Iron and Copper. If either of these metals be combined with Sulphur, and the compound gently roasted or calcined, only the inflammable part of the Sulphur will be dissipated, its acid being retained by the metal, which is thus corroded into a saline concrete, the same as if the pure acid had been applied. The same change is producible, without the application of any external heat, from a bare mixture of Iron filings and Sulphur moistened with water: The matter grows hot of itself, the Sulphur is resolved into its constituent parts, its inflammable principle exhales, and its acid is detained by the Iron. From most of the other metals, Sulphur is expelled by fire in its whole substance.

VITRIOLS. Resolution of Sulphur by metallic substances.

A like resolution happens often spontaneously in the mineral kingdom. There are sundry minerals, which, examined in their natural state, appear to consist of Iron and Copper, blended with Sulphur, and earthy or stony matters. After they have been exposed for a time to the action of the air, we find nothing of the Sulphur left but the acid, by which the metal is now corroded into a saline substance separable from the indissoluble matter by means of water.

Production of Vitriol.

Combinations of metals with the vitriolic acid are called *vitriols* of those metals. It is with manifest impropriety that Boerhaave and others have extended this name to metallic Salts made with other acids: For as one particular acid is universally distinguished by no other name than that of the acid of Vitriol, it must surely be productive of great confusion, to call those substances vitriols, whose acid is of a different kind.

VITRIOL.

THERE are Vitriols of three metallic bodies, produced spontaneously, or with little assistance from art; those of Iron, of Copper, and of Zinc. The pure vitriol of Iron is of a grass-green colour verging to blackish; that of Copper, of a beautiful sapphire blue; and that of Zinc white. The Vitriol of one metal has frequently an admixture of that of another; and hence arises a fourth arrangement, of greenish blue and bluish-green, according as Iron or Copper prevail in the compound (*b*).

Different sorts of Vitriols.

Vitriols

proposed to the chemists, "to separate the "vitriolic acid from fixed alcaline Salts, "instantly, and in the palm of the hand." Mr. Geoffroy has given a Memoir on this problem; in which he endeavours to resolve it by changing the acid into Sulphur; namely by melting the vitriolated Alcali with inflammable matters by a strong fire, till the acid is combined with the phlogiston into Sulphur, (See page 164.) then dissolving the compound in water, and precipitating the Sulphur with acids: He thinks it sufficient that this last part of the process be performed in the hand, though the separation of the acid was effected in the fire.

(*b*) *Vitriols.*] These Salts are remarkably lighter than might be expected from the large quantity of metallic matter they contain: Even when freed by fire from their watery phlegm, they are less ponderous than the Salts composed of the same acid and fixed alcalies, in the proportion of about 2 to 2 $\frac{3}{10}$.

VITRIOLS. Method of preparing them. Pyritæ. Vitriols are prepared in Sweden, in ſeveral parts of Germany, &c. from the yellow ſulphureous Pyritæ, whoſe metallic part is chiefly Iron; and from ſome other minerals of the ſame kind, impregnated with Copper. The firſt are of a pale yellow colour, and commonly approach to a cubical figure: The latter are of a deeper greeniſh yellow or Gold colour, and in figure more irregular. Both ſorts are compact and hard, and diſcover in their natural ſtate no marks of Vitriol, but yield Sulphur in abundance. Expoſed to the atmoſphere, either entire or reduced into powder, they ſuffer no perceptible change: But if gently roaſted or calcined, and then laid for a time in the air, they acquire a ſtrong vitriolic taſte, and readily give out to water the Vitriol now produced in them. Thoſe in which the quantity of Sulphur greatly prevails above that of the metallic matter, are worked for Sulphur firſt: After ſo much of the Sulphur has been extracted, as can be commodiouſly ſeparated by the common proceſſes of ſublimation or eliquation, enough is ſtill retained by the metal to convert greateſt part of it into Vitriol.

There are other kinds of Pyritæ, very different in quality from the foregoing. Thoſe from which Vitriol of Iron is prepared in large quantity at Deptford near London, and which are brought thither by water, chiefly from the Iſle of Wight, under the name of Copperas ſtones, contain very little Sulphur, though on expoſure to the air they become plentifully impregnated with vitriolic acid; and hold a ſtill ſmaller portion of Iron, inſomuch that it is neceſſary to add freſh Iron to ſaturate the acid. Theſe ſtones are conſiderably hard and compact, commonly of a roundiſh figure, of a ſparkling whitiſh grey colour, ſometimes as large as the fiſt, and ſometimes much ſmaller. They have no manner of taſte, and give out nothing to water by long boiling. Diſtilled in a retort, they yield a little ſulphureous Sublimate, and a browniſh or milky liquor of a ſtrong ſulphureous ſmell: On the reſiduum I made forty different experiments with reductive fluxes, but obtained no appearance of any metallic Regulus. The crude ſtones, expoſed entire to the air, loſe their brightneſs, and change to a dull grey colour; the ſuperficial parts ſcale off, and become powdery; and by degrees the whole ſtone is converted into powder, without the leaſt aſſiſtance from art. What was before Sulphur, is now vitriolic acid: The powder has a ſtrong, acid, ſtyptic, vitriolic taſte; and yields, with the addition of Iron or Copper, a green or a blue Vitriol. The ſtones are found to differ in regard to the length of time neceſſary for producing theſe changes: For ſome, a few weeks are ſufficient; others require a twelvemonth; and others, as Boyle obſerves, a year and a half.

Engliſh Coperas ſtones.

Theſe kinds of ſtones are not peculiar to England. There are Pyritæ in ſeveral other countries, at Saalfeld, in Heſſia, in Bohemia, about Liege, &c. which yield Vitriol by a like treatment; and require no calcination or other artificial operations, to render them vitriolic. The bituminous wood, found plentifully in the pits where Amber is dug, becomes alſo vitriolic by lying in the air; and a very little air is ſufficient for that effect. I kept ſome hard compact pieces of this wood, in a covered box, in a temperate place, for ſome years: They retained their figure, and ſtill exhibited marks of the woody fibres, but fell in powder on being touched, and appeared throughout vitriolic: Some other pieces, kept for the ſame length of time in a cloſe ſtopt glaſs,

Vitrioleſcent wood.

retained a degree of firmneſs. Pyritæ are likewiſe converted into a vitriolic ſtate in covered veſſels, though more ſlowly than in the open air. VITRIOLS.

Preparation of Copperas at Deptford.

At the Vitriol works at Deptford, the ſtones are ſpread, to the depth of about half a foot, upon an area of ſeveral hundred roods, whoſe bottom is compoſed of clay, mixed perhaps with other ſubſtances, made ſloping, and beat ſolid and ſmooth, ſo as that water may run off. From the upper ſide of the grounds to the lower are dug ſmall channels, at diſtances of about ten paces; by which the vitriolic matter, waſhed out from the mineral by rains, is carried down into wooden troughs placed tranſverſely at the lower ſide. Every two of theſe troughs empty themſelves into a wooden ciſtern ſunk in the ground betwixt them. From theſe the liquor is laded up with wooden jets: If ſufficiently ſtrong, it is conveyed along a trough into the boiling houſe: If too dilute, from immoderate rains or other cauſes, it is returned, by another canal properly diſpoſed for that purpoſe, upon the ſtones in the upper part of the Vitriol ground. In great droughts, the deficiency of rain is ſupplied by artificial watering——The vitriolic liquor is boiled down in large, oblong, ſhallow, leaden pans, with the addition of ſuch old Iron as is procurable at a cheap rate. When evaporated to a proper pitch for ſhooting, it is conveyed by troughs into long pits made in the earth, narrow at bottom, and wider at top: In theſe, great part of the Vitriol cryſtallizes; after which, the uncryſtallized liquor is returned to the boilers with freſh vitriolic ley; and the proceſs repeated till ſcarce any thing more will ſhoot. This liquor is purchaſed by ſome particular perſons, under the name of mother-ley: When the workmen have large quantities, they return it upon ſuch Pyritæ as have not been compleatly changed into a vitrioleſcent ſtate. The cryſtallized Vitriol is carried into the drying-houſe; and after ſufficient exſiccation, packed up in caſks for ſale. The work is carried on without intermiſſion; the Vitriol grounds being divided into a number of compartments, that one parcel of the mineral may be ready to yield its acid, by the time that another is exhauſted.

Cryſtallization.

Deptford is the only place where Vitriol is cryſtallized in pits made in the earth The cryſtallization is commonly performed in large wooden tubs, fitted with perforated covers; a long ſtick being thruſt, through every hole of the cover, to the bottom of the veſſel, for the Vitriol to ſhoot upon: The ſticks are frequently joined in pairs, by croſs pieces at the lower end, like the Greek Π. The cryſtals are knocked off, dried a little, and put up in caſks.

Vitriolic waters.

There are ſundry waters naturally impregnated with Vitriol; the greater number with that of Iron; ſome with that of Copper; to which, in ſome waters, the Vitriol of Zinc is ſuperadded. All the Chalybeate ſprings, as thoſe of Pyrmont, receive their Virtues from a Vitriol of Iron, produced by a ſpontaneous reſolution of Pyritæ. The vitriolic acid has a principal ſhare in the impregnation of all the mineral waters: Even thoſe which contain an alcaline Salt, as the Carlſbade waters, ſeem to owe their Alcali to this very acid. This alcaline Salt differs in ſeveral reſpects from vegetable alcalies, and appears to be the ſame with the baſis of Sea-ſalt: There is abundant reaſon to believe, that it has been actually taken from Sea-ſalt by the vitriolic acid; and that this acid afterwards forſook, and left it in the water, to unite with ſomething elſe, perhaps with calcareous

VITRIOLS. calcareous earths; for the vitriolic acid has a ſtrong attraction to theſe earths, and when combined with them, forms an inſipid ſelenitic concrete, which we find really to exiſt in waters (*c*).

In

(*c*) *Impregnation of mineral waters.*] From the foregoing ſhort ſketch of the impregnation of mineral waters, our author appears to have had a more thorough knowledge of this ſubject than any who has written ſince. Mineral ſpirits, unſupported by experiment, have been called in aid to account for the phænomena; whilſt the natural affinities of the vitriolic acid, and its obvious tranſpoſitions from one body into another, have been overlooked. The following experiments tend to confirm the authors ſuggeſtions, and will probably give ſome further light into this affair.

1. If common Salt and Vitriol of Iron be diſſolved ſeparately in water, and then mixed together; the ferrugineous part of the Vitriol will ſeparate and fall to the bottom, its acid uniting with the alcaline baſis of the Sea-ſalt, and forming, with that, a new compound, the *cathartic Salt* or *Sal mirabile* of Glauber.

2. If, inſtead of Sea-ſalt or its ſolution, we take the earthy ſubſtance called *Magneſia alba*, or a ſolution of it in the vegetable, nitrous or marine acids, a like reſolution happens, the acid of the Vitriol depoſiting its metallic baſis, and uniting with the earth. The new ſaline compound, produced in this caſe, is the *bitter cathartic Salt*, the ſame with that obtained from the purging mineral waters.

3. On mixing a ſolution of *Glauber's Salt* with calcareous earths or ſolutions of them, Lime-water for inſtance; the vitriolic acid of the Glauber's Salt forſakes its alcaline baſis, and unites with the calcareous earth: With this laſt it forms a ſelenitic concrete, very ſparingly diſſoluble in water, and which, on ſtanding, in greateſt part ſubſides, leaving in the liquor little other than the diſengaged alcaline Salt. It is needleſs to mention, that if the quantity of Glauber's Salt is large, in proportion to that of the calcareous earth, only a part of it will thus be reſolved.

4. On ſubſtituting the *bitter cathartic Salt* to Glauber's Salt, the event is the ſame; calcareous earths abſorbing a part of the acid of that Salt alſo, more or leſs in proportion to their own quantity, and forming with it a ſelenites: Only here, as the baſis of the bitter purging Salt is an earth not diſſoluble in water, this earth ſeparates and ſubſides, as ſoon as it is deprived of its acid. As the earthy matter, which remains upon conſiſts partly of this earth, and partly of Selenites, we may preſume, that a part of the ſalt of the water was thus deſtroyed in the evaporation; that a part of its acid was transferred from one kind of earth into another; from an earth with which it forms a bitter cathartic Salt, into one with which it compoſes a ſubſtance inſipid to the taſte, and of no purgative virtue. Hence we learn, why the waters themſelves purge more, than the Salt obtainable from an equal quantity of them.

5. If equal quantities of green Vitriol and the mineral alcaline Salt or baſis of Sea-ſalt, be dropt into a ſtrong bottle filled with ſpring-water, and the mouth inſtantly cloſed ſo as to leave no vacuity in the veſſel; the two Salts will be ſlowly diſſolved, and ſubſiſt quietly together ſo long as the veſſel is kept cloſely ſtopt; there being no room for the extrication of the air, which all acids expel from alcalies in uniting with them, and without the expulſion of which they cannot unite with them. As ſoon as the bottle is opened, the Salts begin to act upon one another, and the liquor exhibits the ſame remarkable phænomena, as the natural Chalybeate waters when brought up into the open air: It ſparkles or emits bubbles bles of air, taſtes briſk or ſpirituous as it is called, gives marks both of acidity and alcaleſcence, ſtrikes with galls, not the black which Vitriol does by itſelf, but a fine purple: On ſtanding for a little time, it loſes theſe qualities; the Vitriol is deſtroyed; its Iron falls to the bottom in form of Ochre, its acid being abſorbed by the Alcali. The remaining liquor, evaporated, leaves only a little cathartic Salt, and a part of the Alcali unneutralized; together with a portion of marine Salt and different earths which the ſpring-water contained before.

This

VITRIOLS.

Native Vitriols.

In many places we meet with cryſtals of Vitriol ſpontaneouſly formed in the earth, as at Rammelſberg near Goſlar, in Hungary, &c. Theſe alſo appear to receive their origin from Pyritæ. At Rammelſberg there is abundance of ſulphureous Pyritæ, both cupreous and ferrugineous: Twenty-five or twenty-ſix hundred weight of Sulphur are prepared there every week; and about eighty hundred weight of Vitriol. As at this place there is plenty of the ingredients for the production of Vitriol; ſo neither are the means wanting for its being produced in the mine itſelf. There is heat ſufficient, from the wood fires made for burſting the hard maſſes of ore, for gunpowder is never employed for that purpoſe here: A whole ſtack of wood is ſet on fire at a time, by which the mine is made ſo hot, that the men are obliged to work naked. Water, as in all mines, is but too plentiful; and all the Rammelſberg waters are ſtrongly impregnated with Vitriol: A drop, falling on the clothes, leaves at firſt a ſtain, and in no long time makes a hole. It is little wonder, that in ſuch a place vitriolic cryſtals ſhould be formed. In ſundry caverns of the mine, above, below, hanging from the top and ſhooting up from the bottom, we find icicles of Vitriol, of various ſizes, ſome as thick as the arm, curiouſly cluſtered together, like garden-beds or grotto-work, white, reddiſh, fleſh coloured, green, bluiſh green, of a pure blue; affording, eſpecially when viewed by candles, a moſt beautiful ſpectacle.

Preparation of white Vitriol.

At this place, the white Vitriol is prepared; from a mixt ore, containing Sulphur, Zinc, Calamine, Copper, Iron, Lead, and other metallic ſubſtances. The ore is roaſted, and elixated with freſh parcels of water; the liquor ſet by to ſettle, then boiled down in leaden pans, and cryſtallized. If the cryſtals have any reddiſh tinge, which they commonly have, they are again calcined, diſſolved in water, the ſolution purified by ſettling, evaporated till it becomes thick, and then poured into moulds: This proceſs is repeated till the matter becomes ſufficiently white. As there is little conſumption for this kind of Vitriol, it is made but ſeldom; ſometimes ſcarcely once in ſix or ſeven years. The ore remaining after the extraction of the Vitriol, is ſmelted as freſh ore. The white Vitriol has hitherto been prepared at Rammelſberg only: It is ſaid that a little begins now to be produced in Hungary.

Converſion of one kind of Vitriol into another.

The vitriolic acid has a greater affinity with Iron than it has with Copper. If vitriol of Copper be diſſolved in water, and ſome clean Iron added to the ſolution, the acid will let the Copper fall, and take up a proportionable quantity of the Iron: The blue colour of the liquor is now changed to a green; and on evaporating and ſetting it to ſhoot, we obtain, inſtead of the blue vitriol of Copper, a green one of Iron. The Copper in this experiment is extricated from the acid in its metallic form, and adheres all over the ſurface of the Iron: If the Iron is in thin pieces, and its quantity duly proportioned to that of the acid, nearly the whole of the Iron will be extracted, and a maſs of Copper of the ſame figure left in its place. Hence aroſe the ancient conceit, of Iron being

This experiment may give, perhaps, no unjuſt idea of the natural impregnation of Chalybeate waters in the bowels of the earth; and of the manner in which they loſe their peculiar qualities, and depoſite their ferrugineous ingredient, on being brought into a ſtate of leſs confinement.

VITRIOLS. being tranſmuted into Copper by the waters of Neuſol in Hungary; which waters are no other than a natural ſolution of venereal Vitriol. The Copper thus obtained from them is very pure and high coloured: It is commonly called *Cement-Copper*, but might be named with greater propriety, precipitated Copper.

Blue Vitriol may in like manner be converted into white, by the addition of Zinc; that ſemimetal precipitating the Copper as readily as Iron does. It has been ſaid, that Zinc precipitates Iron alſo from the vitriolic acid, and that green Vitriol may thus be converted into white. But on trial it did not appear that Zinc precipitated any more of the Iron than would have fallen ſpontaneouſly; the ferrugineous ſolution, after digeſtion both with Zinc and with its ore Calamine, yielding ſtill not white but greeniſh cryſtals

Adheſion of the acid in different Vitriols.

It is obſervable that the adheſion of the acid with the ſeveral metals is not in proportion to its degree of affinity or appetite of union with them, but the very reverſe. Though it readily and totally forſakes Copper upon preſenting to it Iron or Zinc, it is nevertheleſs far more difficultly diſunited by fire from the former than from either of the latter: It is expelled from Zinc the moſt eaſily of the three.

Gold not contained in Vitriols.

There is rarely or never any metallic body beſides theſe in the compoſition of Vitriols; though ſome have imagined that theſe Salts are impregnated with Gold. There are indeed inſtances of a little Gold having ſometimes been extracted from them: But the Gold thus obtained was by no means an ingredient in the Vitriol as ſuch; and had only been caſually embedded in the maſs, as it is in different ſtony and earthy matters in the Gold mines. Thoſe who have been deluded into the moſt ſanguine expectations by experiments on a ſingle ſpecimen, have been convinced of this truth upon ſubmitting another parcel to the ſame trials.

The alchemiſts have expected to find in Vitriol no leſs than an univerſal medicine, and the philoſophers-ſtone. With them the metallic part of the Vitriol precipitated by fixt alcaline Salts, has been eſteemed a ſolar Sulphur, and celebrated as an anodyne of extraordinary virtue. They have treated, by a variety of operations, the cryſtallized Vitriol itſelf, the liquor which remains after its cryſtallization, the rainbow-coloured cuticle which forms upon ſolutions of it; but have always been diſappointed in their aim. The following ſentence, whoſe initial letters compoſe the word *Vitriolum*, has animated them in the purſuit; *Viſita interiora terræ, reperies ibi occultum lapidem, veram medicinam*; that is, "Viſit the inner parts of the earth, and there you ſhall find "the hidden ſtone, the true medicine." Another ſentence, whoſe initials in like manner make up the word *Vitriolum*, is much more juſt; *Via iſta theſauros requirendo inutilem operam luſerunt viri multi*; "Many have ſearched for trea-"ſures in that way, and beſtowed their labour in vain."

I. VITRIOL *of* IRON.

VITRIOL of Iron diſſolves in about twice its weight of water, into a green liquor; and on duly evaporating the ſolution, and ſetting it to ſhoot, concretes again into thick rhomboidal cryſtals: If the cryſtallization is performed in a warm place, the Vitriol commonly riſes up above the liquor, and concretes into efflorescences about the edges of the veſſel. It retains in its cryſtalline form a large quantity of water, amounting to full as much as the metal and acid together. In a warm dry air it loſes a part of its water, and falls by degrees into a white powder. VITRIOL OF IRON. General properties.

On diſſolving the powder or the cryſtals in water, a portion of the Iron is left undiſſolved at the bottom of the veſſel (*d*), in form of a reddiſh yellow or ruſty-coloured calx or ochre: The exſiccated powder leaves conſiderably more of this ochre than the cryſtals. The ſolution depoſites, on ſtanding, more and more of the metal in the ſame form; and being now evaporated yields cryſtals paler coloured than at firſt, with an unctuous liquor, which refuſes to cryſtallize, and which on further evaporation forms a butyraceous maſs that deliquiates in the air. How often ſoever the ſolution and cryſtallization are repeated, a part of the Iron remains always undiſſolved, a part ſeparates ſpontaneouſly from the ſolution, and a part is reduced into a butyraceous matter; the cryſtals being paler and paler till the whole quantity is thus deſtroyed or reſolved. The further the cryſtals are freed from their metal the more eaſily do they part both with their water and their acid. Changes produced by repeated ſolutions.

The cryſtals, expoſed to a gentle fire, liquefy and boil up: and having gradually diſcharged the greateſt part of their water become conſiſtent again, with the loſs of their tranſparency and green colour. The maſs, when it firſt becomes ſolid, appears of a whitiſh colour: On urging it with a ſtronger fire, acid fumes ſucceed the watery ones, the matter becomes yellow, red, and at length of a deep purpliſh red. Effects of fire.

It is from this kind of Vitriol, as being the cheapeſt, that the vitriolic acid has been generally extracted for common uſes. The Vitriol is firſt calcined uſually in Iron pots till it will no longer melt, as its melting in the diſtilling veſſel would endanger burſting it: The calcination is advantageouſly continued alſo beyond this period, as more of the phlegm is thus diſſipated without much loſs of the acid. On collecting the vapours they are found to have very little acidity till the Vitriol has become yellow: From this ſtate to that of redneſs, Calcination of Vitriol.

(*d*) *Spontaneous ſeparation of the Iron from Vitriol.*] A ſolution of the Vitriol in water depoſites, upon ſtanding, a part of its metallic baſis: In length of time, nearly the whole quantity ſubſides, leaving the liquor colourleſs. The precipitation is greatly expedited by a boiling heat; by which more of the metal ſeparates in a few minutes than by ſtanding without heat for a twelvemonth. Upon expoſing the ſolid Vitriol to a moiſt air, a ſimilar reſolution happens on its ſurface; which, in a ſhorter or longer time, according as the Vitriol is more or leſs ſaturated with metal, changes its green to an ochery or ruſty hue. Iron does not ſeparate in this manner from any other acid, nor any other metal from this acid.

VITRIOLS. redneſs, they prove conſiderably acid: All that ariſes after the matter has become red, is a ſtrong concentrated acid.

Oil of Vitriol. The diſtillation is performed in earthen longnecks placed in a reverberatory furnace: The makers of Oil of Vitriol in England put fifty or more of theſe veſſels in one furnace. To each longneck is luted a glaſs receiver; which, if the Vitriol has been fully calcined, need not be large: The neck of the diſtilling veſſel is introduced into the belly of the receiver, leſt the drops falling on the neck of the glaſs ſhould crack it. The fire is raiſed by degrees, and continued for a certain ſpace of time, uſually ſome days and nights; beyond which, experience has taught the workmen that the produce of acid would not pay the expence of fuel; care muſt be taken, in ſupplying freſh fuel, not to crack the veſſels by admitting cold air to them: A volatile ſuffocating ſmell, like that of burning Sulphur, gives notice of ſuch an accident. If the veſſels will bear a good fire towards the end of the diſtillation, we commonly obtain an highly concentrated acid, in a thick butyraceous form, called glacial Oil of Vitriol: In ſuch caſe we muſt be well upon our guard in taking off the receiver; this concentrated acid, as ſoon as any communication with the air is opened, emitting, in great abundance, ſubtile penetrating fumes capable of ſtriking a man dead.

Its colour whence. Oil of Vitriol, as firſt diſtilled, appears of a brown or blackiſh colour, which ſome aſcribe to a portion of Iron or Copper brought over with it in the diſtillation. But neither of theſe metals give any ſuch tincture to this acid: Inflammable ſubſtances do. A ſmall bit of white paper will change the cleareſt Oil of Rectification. Vitriol, in a little time, quite black: The acid thus tinctured, and that which ariſes coloured from the Vitriol, are both rendered clear by the ſame means, barely by being heated. The phlegmatic acid is rectified by diſtillation in a glaſs retort; the weaker acid or Spirit of Vitriol diſtilling, whilſt the ſtronger called Oil remains behind. In this proceſs the retort ſhould be placed, not in ſand as ſome direct, but in *capella vacua* or an empty Iron pot, with only a little ſand ſtrewed on the bottom to keep the retort ſteady: When the glaſs is buried in ſand it is very unequally heated, and hence very liable to crack.

Analyſis of different Vitriols. One hundred pounds of Engliſh Vitriol, calcined to yellowneſs, were reduced to fifty-five pounds, which yielded fifteen pounds of concentrated oil. From a more exact examination it appeared, that ſixteen ounces of this kind of Vitriol contain above eight of water, one and a half of pure acid, and about ſix of Iron; with a ſmall proportion of Alum, too ſmall to be of any importance. The aluminous matter is moſt diſtinguiſhable in the crude liquor of the pyrites, before it has been made into Vitriol; and in this we may diſcover alſo ſome marks of marine acid: The Vitriol itſelf very rarely participates of that acid in any degree.

The Engliſh Vitriol is purely ferrugineous; but there is ſcarcely any other Vitriol of Iron without ſome admixture of Copper. The Goſlarian, Hungarian, Bohemian, Saxon, Ruſſian, Roman, Saltzburg, French, and Swediſh, are all mixed Vitriols; and in proportion as they abound with Copper contain leſs water and more acid than the pure Vitriol of Iron. Sixteen ounces of Goſlarian Vitriol (the ſort commonly made uſe of in Germany) were found to contain ſeven ounces of water, three ounces of acid, five ounces ſeven drams

drams and one ſcruple of Iron, and nearly two ſcruples of Copper: In the ſame quantity of another parcel, the water amounted to ſeven ounces and ſix drams, the acid only to two ounces and two drams, and the metallic matter to ſix ounces: A third parcel yielded leſs water and more acid. Theſe differences depend chiefly upon the age and dryneſs of the Vitriol, a part of the water being diſſipated in keeping. VITRIOLS.

The Vitriols which participate of Copper readily diſcover that metal upon rubbing them on a moiſtened bright piece of Iron, which they inſtantly cover with a cupreous coat. It ſeems as if the metallic part of all Vitriols had been formerly ſuppoſed to be Copper only: Hence even the ferrugineous Vitriols have, in different languages, received names expreſſive of Copper; by the Engliſh they are called *copperas*; by the Germans, *kupfferwaſſer*; by ſome of the Latin writers *cuperoſum* (i. e. *cuprum eroſum*;) by the Greeks χαλκανθος.

Green Vitriol ſtrikes a black colour with vegetable aſtringents; and hence is the baſis of the black dye for cloth, leather, hats, *&c.* The workmen find that the mixed Vitriols anſwer better for theſe purpoſes than the purely ferrugineous; probably from the cupreous part of the Vitriol being more coroſive, more effectually penetrating the ſubject, and thus occaſioning the colouring matter to ſink deeper: The Copper certainly does not contribute to the colour itſelf, for neither the Vitriol of Copper, nor Verdegris, ſtrike any blackneſs with aſtringents. The manufacturers of tobacco are ſaid to make uſe of this Salt for deepening the colour of that commodity. Common ink is prepared from Vitriol and Galls: Bromel tells us that the beſt ink is made according to the old monaſtic verſe, *Uncia ſit gallæ, ſemiſque ſit uncia gummi, Vitrioli pars quarta; his addas octo falerni:* But the liquor thus prepared will not long keep, eſpecially in an open veſſel. To make a black and durable ink, I digeſt ſixteen ounces of bruiſed Galls in two quarts of French white wine for ſeveral days; and then pouring off the wine, gently boil the Galls in two quarts of water: Six ounces of Goſlarian Vitriol are diſſolved in this decoction, the wine added to the ſolution, the mixture digeſted for ſome hours, eight ounces of Gum Arabic put in, and when this is diſſolved, a dozen or more of entire Cloves, which in good meaſure prevent mouldineſs. Some add Sugar, others Salt, and others Spirit of Wine, to keep the ink from freezing in winter. From theſe uſes of the Chalybeate, which is the moſt common of the Vitriols, all the ſorts have been called *atramenta*; and minerals impregnated with them *lapides atramentarii*, *atramentſtein*. Uſe in dying. Ink.

Vitriol mixed with Nitre or Sea-ſalt, and expoſed to the fire, extricates the acids of thoſe Salts; the vitriolic firſt parting with its own acid which thus diſlodges the others in the ſame manner as if Oil of Vitriol had been taken. Hence the uſe of Vitriol in the diſtillation of Aqua fortis. The mixed Vitriols are ſaid to anſwer better for this purpoſe likewiſe than the pure Vitriol of Iron: The Engliſh themſelves frequently employ foreign Vitriols in preference to their own (*e*).

The

(*e*) *Mechanic uſes of Vitriol.*] In the Swediſh Tranſactions, Vitriol is recommended as a yellow for houſe-painting: Quicklime, made into a paſte with water, is to be diluted with a ſolution of Vitriol, more or leſs according as the colour is required deeper or

VITRIOLS. Medical uſes. The medical effects of Vitriol are ſimilar to thoſe of the other preparations of Iron. The pure Vitriol of Iron is here alone to be uſed: The mixed ſorts may be rendered purely ferrugineous, by diſſolving them in water, and adding ſome bright Iron, which will totally precipitate the Copper; after which the Vitriol is to be recovered by cryſtallization. It is obſervable, that in ſmoking tobacco, a little Vitriol taken into the mouth, leaves, after its aſtringency is over, an agreeable ſweetneſs——Externally, this Salt is employed as a ſtyptic, either diſſolved in liquors or calcined. The *ſtypticum heroicum*, as it is called, is compoſed of a pound of Hungarian Vitriol and half a pound of Alum diſſolved in three pounds of phlegm of Vitriol, and mixed, after filtration, with five ounces of Oil of Vitriol. Vitriol calcined to whiteneſs, by the ſun's heat in the dog-days, has been celebrated for ridiculous ſympathetic virtues: Sir Kenelm Digby and others have been ſuperſtitious enough to believe, that it would cure wounds by being applied only to the weapon they were made with, reſtrain hæmorrhages by the blood being dropt upon it, and produce various effects in the body by being put into the patient's urine, *&c.*

II. VITRIOL *of* COPPER.

VITRIOL of COPPER. Effects of fire. THE Vitriol of Copper contains much leſs water than that of Iron, and requires a larger quantity, about four times its own weight, for its ſolution. It does not, like the green Vitriol, part with any of its metal on being diſſolved; nor calcine in the air, or liquefy in the fire. Expoſed to a gentle heat it firſt turns white, and then of a yellowiſh red colour: On urging it with a ſtronger fire the acid ſlowly exhales, and a dark red calx of Copper remains, of a much leſs lively colour, and inclining more to a brown, than the calx prepared in the ſame manner from the Vitriol of Iron. The whole of the acid cannot be ſeparated by diſtillation from either ſort; ſo much acid remaining united with the metal after that operation as to render a part of it ſoluble in water: After this ſoluble part has been extracted, a little acid is ſtill retained, amounting to about one twenty-fourth part of the metallic calx.

Vitriol of Copper is commonly called Cyprian, probably from its having been formerly brought from the iſland Cyprus in the Egæan ſea. Boerhaave makes the Cyprian and Hungarian Vitriols the ſame, but they differ greatly from

or lighter: The mixture appears of a bluiſh green colour, and does not become yellow till it is dry. One part of Vitriol is ſaid to go as far as two of the dearer yellow Ochre.

This Salt is recommended alſo for preſerving wood, as particularly the wheels of carriages, from decay: When all the pieces are fit for being joined together, they are directed to be boiled in a ſolution of Vitriol for three or four hours, and then kept for ſome days in a warm place to dry. It is ſaid that wood by this preparation becomes ſo hard and compact that moiſture cannot penetrate it; and that Iron nails are not ſo apt to be deſtroyed by ruſt in this vitriolated wood as might be expected, but laſt as long as the wood itſelf.

There are ſome inſtances ſufficiently atteſted of human carcaſſes being preſerved for a number of years, in vitriolic mines, free from corruption. In a hiſtory of this kind related in the literary acts of Sweden, all the natural features remained unaltered, though the body had lain forty-nine years: The fleſh was grown of a horny hardneſs.

from one another, the former being a pure Vitriol of Copper, the latter a mixt Vitriol of Iron and Copper. VITRIOLS.

Vitriol of Copper is never produced by nature without an admixture of Iron. The pure venereal Vitriol is made by art, from cuttings or waſte pieces of Copper, ſtratified and cemented with Sulphur: The cover of the cementing-pot is perforated with one or two ſmall holes, and the cementation continued, with a gentle fire till the inflammable part of the Sulphur is conſumed: The matter is then boiled in water, and the liquor, after due evaporation, ſet to ſhoot. Such part of the Copper as remains uncorroded, is treated with freſh Sulphur, till the whole of the metal is changed partly into Vitriol, and partly into an indiſſoluble calx. For the inferior kinds of this Vitriol, Pyritæ abounding with Sulphur are ſubſtituted to pure Sulphur. There are few places in which Vitriol of Copper is prepared, the conſumption of this commodity not being very conſiderable. Preparation.

Vitriol of Copper has been recommended in all kinds of intermittent fevers, in the lepra, and when ſaturated with volatile alcaline ſpirits, as a ſpecific in epilepſies. In this laſt caſe I have known it given with very ill ſucceſs, the convulſions being made by it far more violent. Its internal uſe is in no caſe to be ventured on, as it poſſeſſes a truly deleterious quality, in common with the other preparations of Copper: The ſmalleſt portion occaſions a ſickneſs and nauſea; a ſomewhat larger, reachings and violent vomitings, accompanied often with convulſions: If the quantity taken has been conſiderable, and is not ſoon diſcharged by the vomiting, the ſtomach and inteſtines are corroded, intenſe pains, inflammations, and death ſucceed——Externally, it is uſed as a mild eſcharotic, in ſhankers, and for conſuming proud fleſh: and for reſtraining hæmorrhages. It is applied by the farriers againſt films on the eyes of cattle. Medical uſes.

III. WHITE VITRIOL.

THERE have been many different, and for the moſt part erroneous, conjectures about the nature aud compoſition of this kind of Vitriol. Boerhaave ſuppoſes it to be no other than Vitriol of Iron exſiccated ſo as to become white. Geoffroy comes nearer the truth, in ſaying it conſiſts of vitriolic acid united with Calamine, or with a ferrugineous earth and Lead or Tin. Tin however muſt be excluded from the compoſition, as nothing of that metal is diſcoverable either in the Vitriol itſelf, or in the ores from which it is prepared. WHITE VITRIOL.

Experiment ſhews, that the metallic part of white Vitriol is principally Zinc: When freed from its acid by ſtrong fire it tinges Copper yellow, or changes it into a kind of Braſs, the diſtinguiſhing character of that ſemimetal. It participates alſo of the Iron and Copper, and perhaps of the Lead, with which the ores abound. That it contains Iron appears from the ochery ſediment which ſolutions of it depoſite on ſtanding; and ſtill more evidently, from its yielding, when treated with inflammable fluxes, particles of true Iron to the magnet. Rubbed on a poliſhed moiſt knife, it ſtains the Iron of a Copper colour: Zinc, added to ſolutions of it, throws down a Precipitate, which Analyſis.

VITRIOL. gives a deep blue tincture to Spirit of Sal ammoniac; plain proofs of its holding Copper.

White Vitriol diſſolves as eaſily as the green, in twice its weight of water. It does not calcine or fall into powder in the air, nor liquefy in the fire. In diſtillation, four ounces yielded about an ounce of phlegmatic ſpirit, nearly three ounces remaining in the retort: The ſpirit, examined by alcaline Salts, was found to contain only half a ſcruple of pure acid to ſeven drams and fifty grains of water. If the fire had been continued for ſome days longer, more acid would probably have been obtained.

Medical uſes. White Vitriol was given formerly as an emetic, from a ſcruple to half a dram, two ſcruples, and ſometimes a whole dram; either in its common ſtate as brought into the ſhops, or purified by ſolution and cryſtallization, when it is called *gilla theophraſti*. At preſent its uſe in that intention is almoſt entirely laid aſide: and indeed it may very well be ſpared as an emetic; two or three grains of emetic Tartar, or a little wine impregnated with glaſs of Antimony, operating as effectually as a dram of white Vitriol, and with much leſs ſickneſs or uneaſineſs to the patient. Some report, that both the white and blue Vitriols occaſion a ſalivation: This is by no means to be underſtood as a ſalivation ſimilar to that brought on by mercurials, and is no other than a diſcharge of phlegm or water from the nauſea which they excite. White Vitriol is in common uſe externally, in ointments and collyria, againſt heat, inflammations and defluxions of the eyes: Sometimes a little Sugar of Lead is added. It is one of the beſt applications for theſe purpoſes, and I have known it a very lucrative ſecret in particular hands. It is likewiſe a powerful and ſafe errhine, of good uſe in catarrhs, and obſtructions of the noſtrils by indurated mucus: A ſolution of the Vitriol in Marjoram water is to be ſnuffed up the noſe, or a bit of cloth dipped in it occaſionally introduced. Conſiderable quantities are uſed by the farriers, and thoſe who prepare varniſhes: It is ſaid to promote the drying of varniſhes and oil paints.

ARTICLE III.

Combination of the vitriolic acid with earths.

Experiments on calcareous earths and vitriolic acid. THE Vitriolic acid readily and totally diſſolves the aſhes of vegetables into a limpid liquor. Calcareous earths are corroded but not diſſolved by it: With theſe it forms a ſelenitic matter, in appearance reſembling a Salt, but differing from bodies of that claſs in wanting taſte and ſolubility. When the earth is previouſly diſſolved in water it forms with the vitriolic acid a like concrete, which refuſes to diſſolve again: Three quarts of Lime-water were ſaturated by ſix drams of Spirit of Vitriol, of moderate ſtrength; and being then evaporated left near two drams of this matter in little maſſes like fine flowers of Benzoine. Half an ounce of green Vitriol, diſſolved in water, required for its ſaturation eight pounds and four ounces of Lime-water: The metallic calx, precipitated by the earth of the Lime-water, weighed one dram and eighteen grains: The liquor filtered and evaporated, left only a dram and a half of a whitiſh ſomewhat ſparkling concrete. To ſixteen ounces of Quick-lime in ſubſtance,

ſubſtance, put into water enough to ſlake it and well ſtirred together, I added by degrees Goſlarian Vitriol till the Lime was ſaturated, and a freſh addition occaſioned no further efferveſcence; three pounds and a half were requiſite for this purpoſe: The matter being now elixated with water, and the liquor evaporated, only one ounce three drams and ten grains were found to have been taken up by the water: The undiſſolved part weighed when dry, three pounds and nine ounces. The part which the water had diſſolved at firſt would not any longer diſſolve after it had once been ſeparated. ALUM.

There is another kind of earth, which the vitriolic acid diſſolves with eaſe; and with which it concretes into an aſtringent Salt readily ſoluble in water, called Alum. This earth is commonly ſaid to be chalky; but I have treated Chalk, Lime, Boles, Lac lunæ, and various other earths with Spirit of Vitriol, without being ever able to produce any Alum. What this earth really is, remains as yet unknown. It does not ſeem to exiſt naturally in the ores from which Alum is prepared, in the ſame ſtate wherein it enters the compoſition of Alum; but to receive its peculiar properties from the calcination and expoſure to the air neceſſary for the production of that Salt. In the ſeveral Alum-ores which I have had an opportunity of examining, there was no mark of ſuch an earth as we obtain from Alum (*f*). Aluminous earth.

I. ALUM.

NATURE produces no perfect Alum, but affords the materials for it in ſundry ores, pyritæ, ſtones, ſlates, earths, waters, and bitumens as pit-coal. The reddiſh Roman Alum is prepared from a reddiſh ſtone found at the bottom of the hill Tolfa near Civita Vecchia in the eccleſiaſtical ſtate: In Sweden and ſome parts of Bohemia Alum is made from Pyritæ and other ores; in England, at Altſattel and ſundry other places, from bituminous minerals of the pitcoal kind; at Solfatara near Naples, from a whitiſh earth; in Miſnia, from a blackiſh one; at Leowenberg near Freyenwalde, from a reddiſh one; and Natural hiſtory of Alum

(*f*) *Earth of Alum.*] Some later experiments, by Mr. Geoffroy and Mr. Pott, have ſhewn, that the earth of Alum is contained in clay, and that a true Alum may be prepared by digeſting clay in the vitriolic acid. Both theſe gentlemen imagine, that only a particular part of the clay is here extracted: Whether it exiſted originally in the clay, poſſeſſed of the ſame properties which it is found to have when extracted, or whether it has ſuffered a change in the operation, they have not determined. From the experiments I have made, the latter ſeems to be the caſe. Powdered tobacco-pipe clay being boiled in a conſiderable quantity of Oil of Vitriol, and the fire continued to dryneſs, the matter, examined when grown cold, diſcovers ſcarcely any taſte, or only a ſlight acidulous one: On expoſure to the air for a few days, greateſt part of it is found changed into lanuginous efflorescences in taſte exactly like Alum: The remainder, treated with freſh Oil of Vitriol in the ſame manner, exhibits the ſame phænomena, and this repeatedly till nearly the whole of the clay is converted into an aſtringent Salt——If the earth be ſeparated again from the acid, (by diſſolving the Salt in water, and precipitating with any alcaline Salt) it is now found to diſſolve with eaſe in every acid; to form with the vitriolic Alum again; with the nitrous, a compound reſembling Alum in taſte; with the vegetable acids, a ſubſtance leſs aſtringent, and leſs ungrateful.

ALUM. and from different minerals at Saalfeld, Reichenbach, Leuſerſdorff, Suſerſdorff, Eliard, Schwentzel, Duben, &c. There are waters impregnated with Alum, though I have never ſeen any that left a perfect Alum on bare evaporation.

The pureſt and moſt perfect Alum-ore is the reddiſh ſtone of Tolfa: This is ſaid to yield Alum without any additional matter, though not without artificial managements: The Alum obtained from it is tinctured with the reddiſh colour of the ſtone. In its natural ſtate it gives no marks of Alum; and if expoſed to the air, it continues a hard inſipid ſtone. Calcined or roaſted, and then laid for a time in the air, it becomes by degrees aluminous, and gives out its Alum on being boiled in water. This is the Alum which the Italians call *Alume di rocca*, Alum made from a ſtone or rock: Among us, the name *Alumen rupeum* or rock Alum is often applied to the larger cryſtalline maſſes, whatever ſubject they have been prepared from.

The aluminous Pyritæ and bitumens require no calcination unleſs they greatly abound with Sulphur. Theſe minerals, as firſt taken out of the earth, are compact, and often bright and glittering: They have no manner of taſte, and diſcover no mark of their holding any thing ſaline; the vitriolic acid being as yet blended with an inflammable matter, by which its acidity and all its ſaline characters are deſtroyed. On bare expoſure to the open air, the inflammable principle is diſſipated, and the acid is combined with the aluminous earth into a perfect Alum, the ſtone at the ſame time falling into powder.

Preparation. The mineral thus impregnated with Alum, is elixated or boiled with water; the liquor boiled down, commonly with an addition of urine, or alcaline ley, or both together; the clear part poured off and ſet to ſhoot; the cryſtals, if not ſufficiently pure, diſſolved again, boiled down with a little more Alcali, and cryſtallized afreſh. The uſe of the urine or alcaline Salt is partly to clarify the liquor and precipitate ſuch metallic parts as it may contain; and partly to give a body to the Alum, and promote the cryſtallization: The liquor of itſelf would not ſhoot, but either continue fluid, or if further evaporated, would yield only an unctuous maſs. Alcaline Salts are found to anſwer better than urine, and hence are now in moſt places alone made uſe of, though ſome ſtill retain urine, from prejudice and cuſtom. The Alcali precipitates not only metallic matters, but a groſs earth which would injure the tranſparency of the Salt; and often alſo a part of the aluminous earth itſelf, which falls to the bottom in form of a fine white meal, called at the works Alum meal: This is to be rediſſolved and cryſtallized afreſh. The mineral remaining after elixation, expoſed for ſome years to the air, becomes impregnated with Alum again; in ſome places this proceſs is repeated a third and a fourth time.

Some earths, as the Alum earth of Solfatara, and the aluminous ſlates, have a manifeſt aluminous taſte when newly dug; and hence are directly elixated, without expoſure to the atmoſphere. In ſome kinds of ſlates, we may plainly diſtinguiſh the aluminous matter lying in a powdery form, betwixt the flakes or ſcales of which the ſtone is compoſed. In general, where the mineral holds but little Sulphur, it is ſufficient to lay it for a time in the open air, defended from rain by a ſhed or ſlight covering: If it participates conſiderably of Sulphur, it muſt be previouſly calcined: If very rich in Sulphur, a part of the

the Sulphur is firſt extracted by ſublimation, and the reſiduum worked for Alum. ALUM.

The Alum ſlates near York in England are conſiderably ſulphureous: By lying long in the air, they become aluminous of themſelves, but to promote this effect they are uſually calcined. The boilers are large leaden pans, nine feet long, five feet broad, and two and a half in depth: The liquor is clarified and diſpoſed to cryſtallize by the addition of Soda, there called Kelp, and of urine. The Alum-ore of Schwentzel near Duben in Saxony, above five miles from Hall, is likewiſe bituminous: This is firſt calcined, then expoſed to the air, elixated with water, and the liquor boiled down with Potaſh. At Altſattel near Carlſbade, the workmen, when I was there, uſed only urine, of which they received conſtant ſupplies from the neighbouring towns and villages. The moſt curious Alum-ore I know of is in Sweden; Sulphur, Vitriol and Alum being here obtained from one mineral, which appears to be a kind of Pyrites. The Sulphur is firſt extracted by diſtillation: The reſiduum being ſtrongly calcined, boiled in water, the liquor duly evaporated and ſet to ſhoot, the Vitriol cryſtallizes: The uncryſtallized liquor, treated with urine and a ley drawn from aſhes, yields Alum.

The cryſtallization of Alum is uſually performed in large ſtrong wooden caſks, whoſe ſtaves and hoops are all marked with numbers, that they may be readily put together: In ſome places Iron veſſels are uſed. The caſks being filled with the Alum liquor evaporated to a due conſiſtence, and ſet in a cold place, the Alum gradually ſhoots into large cryſtals about the ſides: The liquor in the middle is then let off by a cock in the bottom, the head of the caſk knocked out, and the veſſel turned upſide down, for the more effectual draining off of the remaining liquid. The cryſtals are then dried in a warm ſtove, and packed up in caſks; and the mother-ley, or uncryſtallized liquor, mixed with freſh aluminous leys. The metallic or vitriolic Alum-ores occaſion the greateſt trouble; and the Alum obtained from them, though it appears white, is never totally free from ſome metallic impregnation. Conſiderable differences are found in Alum, partly from this cauſe, and partly from its being prepared with urine or Potaſh, or with freſh or ſtale urine: Theſe differences are chiefly obſerved by the dyers, and thoſe who prepare lakes for the painters.

Alum requires about ten times its weight of water to diſſolve in. The ſolution if the Alum was pure, makes no change in the colour of Syrup of Violets (*g*); but the common ſorts change the Syrup green, by virtue of the alcaline Salt employed in their preparation. Fixed alcalies, volatile alcalies, and Borax, added to ſolutions of Alum, precipitate the earth. Its taſte is nauſeouſly ſweetiſh and aſtringent. In cryſtallization, it ſhoots into large angular maſſes, conſiſting generally of eleven planes, five of which are hexangular and ſix quadrangular. General properties.

An

(*g*) *Alum changes the colour of Syrup of Violets.*] I have not obſerved any ſort of Alum to mix with Syrup of Violets without changing its colour. Common Alum changes violets, cyanus flowers, and other blue flowers and their infuſions or ſyrups, to a purple or red, as acids do; like which alſo it coagulates milk. It deepens ſome watery tinctures of vegetables, as of Madder and Brazil.

ALUM. Analyſis. An ounce of Alum contains about five ſcruples and a half of earth, one dram and eighteen grains of vitriolic acid, and nearly five drams of water. That its acid is the ſame with that of Vitriol and Sulphur, appears from hence, that it forms with metals a true Vitriol; and with inflammable ſubſtances a true Sulphur——Alum expoſed to the fire, firſt liquefies and boils up like green Vitriol; and when its phlegm is evaporated, forms a white ſpongy brittle maſs: By this treatment it loſes very little of its acid, and hence almoſt totally diſſolves again in water, and ſhoots into hard compact cryſtals as at firſt. The calcined or burnt Alum, as it is called, proves ſharper in taſte than crude Alum, on account of the loſs of its phlegm; and imbibes humidity from the air: Four ounces will, in the ſpace of a month, gain an increaſe of one ounce. Dr. Rhuon expoſed equal quantities of burnt Alum, for equal lengths of time, in a damp cellar, and in a dry upper room: The firſt gained half an ounce, the latter only five ſcruples. If we attempt to extract the phlegm and acid of Alum by diſtillation, we muſt either inject the Alum by a little at a time into a tubulated retort, or put it into a common retort of which it may fill no more than one half, and apply the fire in ſuch a manner, that the matter may be heated firſt on the ſurface, and thence gradually to the bottom. Though the fire is kept up ſtrong for a conſiderable time, we can ſcarce gain more than half the weight of the Alum, of a phlegmatic ſpirit: The reſiduum expoſed to the air, imbibes moiſture, and then yields more of an acid ſpirit, the phlegm ſerving for a vehicle to the acid. Alum diſſolved repeatedly in vinegar, parts with its water more eaſily than at firſt: It now calcines into a white mealy powder, in a warm room, or by the heat of the ſun. If Alum be deprived of its phlegm by moderate calcination, its acid will be in great part abſorbed by rectified Spirit of Wine: On diſtilling off the ſpirit, and cohobating it ſeveral times on the reſiduum, a *Spiritus vitrioli dulcis* will be obtained.

Effects of fire on it, and of air, vinegar, vinous ſpirits.

Schroder relates, that if the phlegmatic Spirit of Alum be cohobated on the remaining burnt Alum, and this proceſs ſeveral times repeated, the whole quantity of the Alum will at length ariſe over the helm by the heat of a water bath: But this is directly contrary to experience. There are two preparations of Alum, whoſe names ſeem to imply a change made in its quality or ſome particular matter extracted from it: One is called *Alumen ſaccharinum*, the other *Saccharum*, *manna*, *dulcedo*, and *primum ens*, *aluminis*. If we expect in theſe preparations what their names import, we ſhall be greatly deceived: The firſt is no other than crude Alum ſoftened into a paſte with whites of eggs and roſe-water, and made up into the form of ſugar loaves: The other is compoſed ſometimes of crude and ſometimes of burnt Alum, made up with common water, Roſe-water, Lime-water, Vinegar, or phlegm of Alum. Some calcine the Alum, then diſſolve it in water, and evaporate the ſolution; and call the Salt thus prepared, *Sal fixum aluminis*; though in no reſpect different from crude Alum.

Black Phoſphorus. Alum calcined with inflammable ſubſtances, particularly thoſe of the animal kingdom, forms a concrete which takes fire ſpontaneouſly on the admiſſion of air, and which is hence diſtinguiſhed by the name of *Pyrophorus*. This preparation was firſt made publick by Homberg, and uſually bears his name though, as Geoffroy informed me, Homberg himſelf learnt it from another perſon.

perſon. The ſame product occurred alſo to me, in making ſome experiments in London, with a different view; and Lemery has given a ſet of experiments expreſsly on the ſubject. The beſt method of preparing this Pyrophorus is, to mix powdered Alum with ſo much yolk of eggs as will reduce it to the conſiſtence of thin honey, and keep the matter conſtantly ſtirring over a gentle fire, breaking from time to time ſuch lumps as may form in it, till the whole is changed into an uniform dry powder. This is to be put into a viol, the veſſel ſlightly ſtopt with paper, ſet in ſand in a crucible over a gentle fire, which is to be gradually increaſed, till the fumes ceaſe, and the matter is moderately calcined: As ſoon as the heat has abated a little, the viol is to be cloſely ſtopt. If a little of this powder be at any time emptied out on a piece of paper, it will preſently take fire and burn like a coal. ALUM.

Alum is uſed in large quantity in ſome mechanic buſineſſes; particularly by the dyers, paper-makers, goldſmiths, bookbinders, for preſerving watery liquors from corruption, for preſerving anatomical preparations, and in the embalming of animal bodies: It is far more powerfully antiſeptic than the Vitriols. As a medicine, it is a ſtrong aſtringent, and hence is ſometimes exhibited in hæmorrhages, dyſenteries, and intermittent fevers; but is not to be ventured on in either of theſe caſes, without extreme caution: Some of the Engliſh phyſicians follow Helvetius's method of mixing the Alum with dragons blood. Externally it is employed againſt inflammations of the eyes, in gargariſms for ſwellings and inflammations of the throat, and for relaxations of the uvula. Uſes of Alum.

II. BITTER PURGING SALT.

THIS Salt was originally prepared from the purging mineral waters of Epſom in Surry, and hence is ſtill diſtinguiſhed by the name of Epſom Salt. Dr. Grew publiſhed ſome experiments upon the water and Salt; which occaſioned them to be brought into ſuch general uſe, that the quantity procurable from the ſpring was inſufficient for the demand. Attempts were made to prepare from other materials a Salt of the ſame properties, and with ſucceſs; the analyſis diſcovered by the gentleman above-mentioned, having afforded ſome foundation to proceed upon. Large quantities of the factitious Salts continue to be exported to France, Germany, *&c.* and are ſold at a very cheap rate. The natural waters of Epſom are now little regarded; and in 1713 I found no perſon there who could give any information about the preparation of the Salt. I inſpiſſated myſelf an hundred quarts of the water, but ſcarcely obtained from them half an ounce of ſaline matter. Bitter purging Salt.

Boulduc relates that the Epſom Salt is made by precipitating a ſolution of Alum with Salt of Tartar, and cryſtallizing the remaining liquor. But in this he is manifeſtly miſtaken; for ſuch a proceſs can afford no other than a vitriolated Tartar; whereas the Epſom Salt, and the Salts of the natural purging waters, are ſimilar to the *Sal mirabile*, of which hereafter. After many weariſome enquiries, I found at laſt, that this Salt was prepared in quantity near Portſmouth, from the mother-ley or uncryſtallized liquor left in the purification of the Bay-ſalt imported from Spain and Portugal. The Epſom Salt is compoſed of an alcaline earth combined with vitriolic acid: This liquor contains the

earth,

PURGING SALT. earth, combined perhaps in part with marine acid: All that is wanting therefore is an addition of vitriolic acid to diſlodge the marine, and for this purpoſe the Iſle of Wight affords Pyritæ in abundance. The method at that time was, to inſpiſſate the mother-ley, add a portion of the liquor of the pyrites, ſlightly calcine the mixture, and then diſſolve, and cryſtallize the Salt: But probably ſome improvements have ſince been made in the proceſs. I communicated theſe obſervations in the year 1714 to Dr. Lentilius in Holland, who publiſhed them without my knowledge, inaccurately and imperfectly, in the *Ephemerides naturæ curioſorum* (*b*).

ARTICLE IV.

Combination of the vitriolic acid with alcaline Salts.

VITRIOLATED TARTAR. THE vitriolic acid, ſaturated with vegetable fixt alcalies, forms a bitteriſh neutral Salt, which ſhoots into ſmall hard cryſtals. This Salt is remarkably ponderous; more ſo than either the acid or the alcali by themſelves, and than any ſaline compound I know of, excepting thoſe which abound with metallic matter, as Mercury-ſublimate. It retains in its cryſtalline form, only a ſmall portion of water. It does not imbibe humidity in a moiſt air, nor become powdery in a warm dry one. It is very difficultly ſoluble in water; being ſcarce at all acted upon by cold, and requiring a large proportion of boiling water: Spirit of wine, added to the ſolution, precipitates the Salt in form of a white

Its properties.

(*b*) *Bitter purging Salt.*] This Salt, which is now extracted by cryſtallization from the bittern of ſea-water, or the bitter liquor which remains after the culinary Salt has ſhot, is ſometimes ſubſtituted in the ſhops to the cathartic Salt or *Sal mirabile* of Glauber: Some have ſuppoſed the two Salts to be perfectly ſimilar, and indiſtinguiſhable from one another.

They agree in having a bitteriſh taſte; diſſolving in leſs than an equal weight of water; ſhooting into long rectangular priſmatic cryſtals; liquefying in a moderate heat, bubbling up into bliſters, and ſoon changing into a white ſpongy maſs, with the loſs of above half their weight of phlegm, whence the calx taſtes bitterer than the Salts did at firſt; and in their being compoſed of the vitriolic acid united with an alcaline baſis.

They differ in the nature of this baſis; that of the bitter purging Salt being a peculiar kind of abſorbent earth, and that of Glauber's Salt a true fixed alcaline Salt. On adding any alcaline Salt, fixed or volatile, to a ſolution of Glauber's Salt, no change enſues; whilſt the Salts obtained from the purging waters, or from the bittern of marine waters, grow milky or curdly on this addition, and depoſite their earth, the alcaline Salt being taken up in its place. Theſe Salts are therefore truly and eſſentially diſtinct, and very readily diſtinguiſhable, notwithſtanding their agreement in ſome of their more obvious appearances.

The earth of the bitter purging Salt is called *Magneſia alba*; and its principal character is, to form with the vitriolic acid a bitter purgative compound. I have no where met with this earth in the mineral kingdom, but in the cathartic Salt itſelf, and in the mother-ley of Nitre, or the liquor which remains after the cryſtallization of rough Nitre. The earth into which vegetable ſubſtances are reduced by fire (at leaſt the woods and herbs which I examined) is exactly the ſame with this; and probably it is from the vegetable aſhes employed in the preparation of Nitre, that the nitrous mother-ley receives its magneſia. The incinerated earths of animals are of a different kind.

white powder like meal. It does not melt in the fire, nor part with any of its acid, nor ſuffer any ſenſible change. Diſſolved in water, it proves in part volatile by the heat in which water boils: By ſtrong continued coction, it may at length be totally diſſipated along with the watery vapour. Vitriolated ALCALIES.

Some differences are obſerved in the quantity of the acid and alcali neceſſary for the ſaturation, and in the phænomena attending the proceſs, according as the plain or cauſtic alcali is uſed, and according to the manner in which the mixture is performed. I prepared a cauſtic alcali, by mixing one ounce of pure alcaline Salt with two ounces of Quick-lime, boiling the mixture in freſh parcels of water till the liquor no longer acquired any ſaline taſte, then filtering the ſeveral decoctions, and evaporating them together to dryneſs. The dry Salt weighed two ſcruples and a half more than the alcali employed; and the remaining Lime weighed a dram leſs than at firſt. Experiments of the ſaturation of the fixt alcalies with vitriolic acid.

To a dram of this cauſtic Alcali, rubbed into powder, Spirit of Vitriol was added by degrees, till the Salt was diſſolved and the effervеſcence ceaſed: The quantity of the ſpirit neceſſary for this purpoſe was two drams. During the effervеſcence, a bright browniſh earth fell to the bottom, which weighed when dry three grains: The filtered liquor depoſited in evaporation firſt five grains and a half of white earthy creme, and afterwards five grains of a yellowiſh one: The dry Salt weighed two ſcruples and eight grains. During the ſaturation aroſe an abominable urinous ſmell, from which the exſiccated Salt was not wholly free.

On inverting the order of mixture, and adding the Alcali by degrees to the acid ſpirit, fourteen grains of the former were found ſufficient for ſaturating two drams of the latter. The ſame kind of ſtench aroſe during the effervеſcence as in the foregoing experiment, and a blackiſh-grey matter fell to the bottom, amounting when dry to fourteen grains: The filtered liquor left on evaporation a dry Salt weighing half a dram all but half a grain.

I repeated both theſe experiments with a pure fixed Alcali. A dram of this required for its ſaturation three drams of Spirit of Vitriol: The liquor left nothing conſiderable on filtration, and being afterwards evaporated, yielded of dry Salt, partly cryſtalline, four ſcruples wanting one grain.

On inverting the procedure, and taking three drams of the acid ſpirit firſt, one dram and nine grains of the pure Alcali were neceſſary for the ſaturation, and half a dram of a white Precipitate fell to the bottom: On evaporating the filtered liquor, the dry Salt, cryſtals and all, weighed two ſcruples and two grains.

When the alcaline Salts were previouſly diſſolved in water, ſome further differences were obſerved. A dram of cauſtic Alcali diſſolved in half an ounce of diſtilled water, required for its ſaturation juſt two drams of Spirit of Vitriol, as the ſame quantity of the Salt had done in its dry ſtate: But no urinous ſmell was here perceived, and a ſcruple of a reddiſh earthy matter precipitated. The filtered liquor evaporated a little, gave eighteen grains of cryſtals, and the remainder inſpiſſated gave ſixteen grains of dry Salt.

On the other hand two ſcruples of Spirit of Vitriol being ſaturated by gradual additions of the cauſtic alcaline ſolution, two ſcruples and eight grains of the Alcali were found ſufficient: During the effervеſcence, there fell half a dram

Vitriolated Alcalies.

dram of an aſh-grey Precipitate: The filtered liquor gave firſt half a ſcruple of greyiſh cryſtals, and on being afterwards evaporated to dryneſs left fifteen grains of Salt.

A dram of pure fixed Alcali diſſolved in half an ounce of diſtilled water, required to ſaturate it three drams of the acid ſpirit, and gave no precipitation: The filtered liquor evaporated a little, yielded twenty-two grains of cryſtals, and on further evaporation two ſcruples and two grains of Salt. The acid being taken firſt, and the alcaline ſolution added to it, two ſcruples of the Alcali completed the ſaturation; the liquor being filtered and evaporated, eight grains of the neutral Salt fell in form of a Precipitate, twelve and a half cryſtallized, and twenty-ſix remained upon continuing the evaporation to dryneſs.

Different methods of preparing vitriolated Tartar.

The neutral Salt compoſed of vegetable fixed alcalies and the vitriolic acid, is commonly called vitriolated Tartar, and employed in medicine as an aperient and gentle laxative. It was formerly prepared by mixing the diluted acid with a dilute ſolution of the Alcali, ſetting the liquor after due evaporation to cryſtallize, and then further evaporating the remainder to dryneſs: By this method, as the exact point of ſaturation is difficultly hit, the Salt frequently proved too acid; and hence its uſe was by many practitioners laid aſide. Otto Tachenius introduced a method more advantageous to the operator, and by which the medicine may be effectually ſecured againſt a redundance of the acid or the Alcali; inſtead of the acid extracted from Vitriol, he takes a ſolution of Vitriol itſelf: On the addition of an alcaline Salt to this ſolution, the acid of the Vitriol lets fall the metallic part, and unites with the Alcali into the neutral Salt required, which is recoverable from the liquor by filtration and cryſtallization. It was a conſiderable time before this method was received in practice, nor was the foundation of the proceſs known till Stahl diſcovered it. The neutral Salt thus prepared was called a regenerated Vitriol, and Salt of Vitriol, ſuppoſed by Tachenius, Boyle and others, to yield its acid in diſtillation in the ſame manner as common Vitriol, to participate of the metallic matter of the Vitriol, whether ferrugineous or cupreous, as well as of the acid. That it may participate of the metal when incautiouſly prepared is certain: Hence it frequently occaſioned nauſea, ſickneſs, and even vomiting: Tachenius himſelf gives it the title of *Sal vomitivum*. Theſe inconveniences depended wholly upon the proportion of Alcali made uſe of being too ſmall to ſaturate all the acid, and conſequently to precipitate all the metal.

To obtain a pure and perfect neutral Salt, the Alcali ſhould be taken in over-proportion; the Vitriol is firſt to be diſſolved in boiling water, and a ſolution of Potaſh or other fixed alcaline Salt gradually added, till the ſaturation appears completed; ſome more of the alcaline liquor is then to be poured in, the whole ſtirred together, the liquor filtered, evaporated till a pellicle appears upon the ſurface, and then ſet to cryſtallize. By this means we are ſecure againſt any metallic taint, and as to the ſuperfluous Alcali it will not cryſtallize: Such part of the Alcali as may adhere ſuperficially to the cryſtals is eaſily ſeparated by rinſing them in water. The liquor which remains after the cryſtallization is to be further evaporated, and ſet to ſhoot again: After it will yield no more cryſtals it may be mixed with freſh ingredients when another quantity of the Salt is to be prepared. There is no occaſion for purifying the

Potaſh or other Alcali for this uſe, as it will be effectually purified in the proceſs itſelf. Vitriolated Alcalies.

This is the moſt commodious and certain method of procuring a vitriolated Tartar perfectly neutralized, and has another advantage above that in which the diſtilled vitriolic acid is uſed, namely, that the ſubtile volatile ſpirit of the Vitriol, called by Helmont *Gas*, which is diſſipated in the calcination of the Vitriol previous to its diſtillation is here preſerved. The ſame neutral Salt may be obtained by proceeding in like manner with a ſolution of Alum inſtead of Vitriol; or by calcining a mixture of Alum or Vitriol with a ſufficient quantity of alcaline Salt, and elixating the compound with water, the acid being thus transferred from the earth or metal into the alcaline Salt as well as when ſolutions of them are mixed, though with leſs certainty; or by expoſing cloths moiſtened with alcaline leys to the fumes of burning Sulphur; or by melting alcalies with Sulphur, and gently calcining the mixt till the inflammable part of the Sulphur is diſſipated; or by expoſing pure alcaline Salts for a length of time to the air. The neutral Salts obtained by all theſe methods are perfectly ſimilar to one another; the acids of Sulphur, of Vitriol, of Alum, and that which is diffuſed through the atmoſphere, being one and the ſame.

The *Nitrum vitriolatum*, otherwiſe called *Arcanum duplicatum*, *Panacea Holſatica*, *Sal ducis Holſatiæ*, *Sal de duobus*, &c. is no other than a vitriolated Tartar, made with the alcaline baſis of Nitre, which is the ſame with the common vegetable alcalies. This is prepared by elixating with water the matter which remains after the diſtillation of the nitrous acid with Vitriol, the acid of the Vitriol having expelled the acid and united with the Alcali of the Nitre. As the Vitriol, however, after this diſtillation retains a part of its acid, ſo as to diſſolve along with the neutral Salt in water, ſome Potaſh ſhould always be added to abſorb the acid and precipitate the metal. Vitriolated Nitre.

The ſame Salt is produced by deflagrating Nitre with a due proportion of Sulphur, the acid of the Sulphur extricating that of the Nitre, and uniting with its alcaline baſis. The Salt thus prepared is called *Sal polychreſtum*, or *Nitrum ſulphuratum*. Sal polychreſt.

Both theſe Salts, though received in the ſhops as diſtinct ones, are found when made in perfection, to be ſimilar in all reſpects to one another, and to the *Tartarus vitriolatus*. The differences ſometimes obſerved in them are entirely caſual: The *Nitrum ſulphuratum* may contain a portion of the Nitre unchanged; and both of them, if the Nitre employed participated of Sea-ſalt, will hold a proportionable quantity of *Sal mirabile*.

Sal mirabile, ſo called by its firſt diſcoverer Glauber, is a combination of the vitriolic acid with the alcaline baſis of Sea-ſalt. As this Alcali is very different from the common vegetable Alcalies, it forms with the vitriolic acid a different neutral Salt, in taſte more bitter, as a medicine more purgative, eaſily ſoluble in water, and when diſſolved coagulating on the admixture of Spirit of Wine; eaſily fuſible in the fire, and diſcharging a large quantity of aqueous phlegm, calcining by a gentle warmth into a white powder. This Salt is prepared from the matter which remains after the diſtillation of Spirit of Sea-ſalt with Oil of Vitriol or with Vitriol in ſubſtance: It may be obtained alſo from the reſiduum after the ſublimation of Mercury-ſublimate, when Sea-ſalt and Vitriol, or its acid without Nitre, are employed in that proceſs. Glaubers Salt.

Vitriolated Alcalies. The vitriolic acid saturated with volatile alcalies forms a neutral ammoniacal Salt, called *Sal ammoniacum secretum* (*i*).

Vitriolic ammoniacal Salt.

CLASS

(*i*) *Secret Sal ammoniac, or vitriolic ammoniacal Salt.*] This Salt has a penetrating pungent taste; and when newly prepared, a sulphureous smell, greater or less according as the volatile spirit made use of was more or less loaded with oily matter. It readily dissolves in water, and increases the coldness of the liquor: On standing for a little time, it begins to separate from the water, and vegetate or arise in efflorescences up the sides of the glass: On moderately evaporating the solution, the Salt shoots into fibrous plates like feathers. It easily melts in the fire, penetrates the common crucibles, and in glass vessels sublimes unchanged.

On exposing to the fire a mixture of this Salt with Sea-salt, two new combinations happen: The vitriolic acid quits the volatile Alcali, and unites with the fixed alcaline basis of the Sea-salt into a Glaubers Salt; whilst the marine acid, thus dislodged from its own basis, unites with the volatile Alcali, which the vitriolic had forsook, into a common Sal ammoniac. The acid of Nitre is also in like manner expelled by the vitriolic ammoniacal Salt. On adding this Salt to a solution of any calcareous earth, as Chalk, in the nitrous, marine, or vegetable acids, the vitriolic acid forsakes its Alcali to unite with the earth, with which it forms a selenitic concrete, which renders the liquor milky or curdly, and on standing falls to the bottom: By this mark, the vitriolic is readily distinguishable from the other ammoniacal Salts, these making no change in calcareous solutions.

This Salt is called *secret* or *philosophic* Sal ammoniac, from the high opinion, which some of the chemists have entertained of its activity upon metals. Mr. Pott has given several experiments on this subject in the Berlin Memoirs; from which it appears, that its effects have been greatly exaggerated; that it dissolves or corrodes in some degree all those metals which Oil of Vitriol dissolves, but has no effect upon those which that acid does not act on by itself.

Gold is not touched in the least, either by the Salt in fusion or by a solution of it: The Salt, added to a solution of Gold in Aqua regia occasions no precipitation or change of colour. On melting the Salt with inflammable matters, it forms a sulphureous compound, which dissolves Gold in fusion, in the same manner as compositions of Sulphur and fixed alcaline Salt—— The vitriolic ammoniacal Salt, melted with Silver, corrodes it into a white calx, which partially dissolves in water: It likewise precipitates Silver from its solution in Aqua fortis——It acts more powerfully on Copper, elevates in sublimation a part of the metal, so as to acquire a bluish colour on the surface, and renders greatest part of the residuum soluble in water. This solution appears colourless, insomuch that it could not be suspected to hold any Copper: It readily discovers however, that it abounds with that metal, by the blue colour which it assumes on the addition of volatile alcalies, and the green calx which fixed alcalies precipitate: In evaporation, it becomes green, without any addition. The vitriolic acid, in a concentrated state, remarkably destroys the colour of cupreous solutions: If to a saturated blue tincture of this metal in volatile spirits, some Oil of Vitriol be added, the blue colour will instantly disappear, and the liquor become limpid as water: On adding more of the volatile spirit, the colour as readily returns——Iron is corroded by the Salt in fusion, and dissolved by boiling in a solution of it——Zinc dissolves more freely and more plentifully—Lead unites with it, but does not become soluble in water—Tin is corroded, and a small portion of the calx dissolves in boiling water—Of Regulus of Antimony also a small portion is made soluble: Alcalies precipitate from the solution a bluish powder —Calcined Bismuth ore, treated with equal its weight of the Salt, partly dissolved in water into a pale red liquor, which became green from heat, in the same manner as tinctures made from that ore by Aqua regia: The undissolved part yielded still with fritt a blue glass——On treating Manganese in the same manner, aluminous crystals were obtained: The undissolved part of the Manganese gave still a violet-purple colour to Glass.

CLASS II.

Nitrous acid and its combinations.

THE nitrous acid is the moſt limited and leaſt frequent in the earth of all the mineral acids. It is ſeldom met with in any combination but in the neutral Salt from which it receives its name, and ſeems to be in that, rather an artificial than a natural production (ſee Nitre). It is ſuppoſed by ſome to be an offspring of the marine acid, with little probability; for the nitrous acid is more powerful than the marine, expelling it from alcaline Salts and earths, which it is not likely it ſhould do if it received its origin from that acid. Others ſuppoſe it on better foundation to be truly the vitriolic acid, altered by putrefaction, and the commixture of ſome inflammable matter. In proof of this opinion, an experiment is alledged, in which the nitrous acid returns back into the vitriolic: If two ounces of good Spirit of Nitre, and half an ounce of Oil of Turpentine be digeſted together, a balſam of Sulphur is produced poſſeſſing all the properties of common balſam of Sulphur. We have already ſeen that Sulphur conſiſts chiefly of vitriolic acid; and whence could that acid be here furniſhed but from the nitrous?

NITROUS ACID. Production.

The concentrated nitrous acid is weaker and much more volatile than the vitriolic. It is in part diſſipated by the action of the air in pungent vapours, which appear before their diſperſion of a red colour: In diſtillation it ariſes in fumes of the ſame colour. If an unſtopt bottle of this ſpirit, and one containing a volatile alcaline ſpirit, be brought near to one another, the vapours of the two liquors unite together, and form a white cloud in the air. An ounce of the concentrated nitrous ſpirit ſaturates near ſeven drams of fixed alcaline Salt, and is found to contain about two drams and a half of pure acid, and five and a half of water.

General properties.

ARTICLE I.

Combination of the nitrous acid with inflammable ſubſtances.

THE nitrous acid mixed with diſtilled oils raiſes a great heat and effervescence, and forms with them a thick reſinous maſs like Turpentine. If the acid is highly concentrated and mixed all at once with ſome of the more ſubtile oils, the matter burſts immediately into actual flame (*k*).

Heat and flame with oils.

It

(*k*) *Flame from nitrous acid and oils.*] This experiment does not ſucceed unleſs the acid is highly concentrated, and even when it is, there are few oils which it will fire with certainty, without the obſervance of a particular circumſtance firſt diſcovered by Mr. Rouelle, and communicated in the French Memoirs for the year 1747. On letting fall into the oil equal its quantity of the acid, the mixture effervesces, ſwells, and a light fungous coal ariſes: A little more of the acid poured upon this coal ſets it inſtantly on fire: By this method, almoſt all the diſtilled oils may be fired by Spirit of Nitre of moderate ſtrength. Expreſſed oils alſo may be ſet on fire by a mixture of the nitrous acid with an equal quantity of Oil of Vitriol; the uſe of which laſt ſeems to be to abſorb

NITROUS ACID.

With vinous spirits.

It raiſes likewiſe a violent ebullition and heat with Spirit of Wine; but this mixture is never obſerved, as ſome have reported, to take fire. The ſafeſt way of mingling theſe liquors is to pour the acid ſpirit by a little at a time into the vinous: If the mixture made with about one part of the Spirit of Nitre to eight of rectified Spirit of Wine be digeſted for ſome days, and then diſtilled in a glaſs retort with a very gentle fire, till only a thick mucilaginous matter remains, the diſtilled liquor diſcovers a grateful ſmell and taſte without any acidity, and hence is called dulcified Spirit of Nitre. I have often obſerved this dulcified ſpirit vary in quality according to the purity of the acid and vinous ſpirits made uſe of, and the manner of preparation. Some of the dulcified ſpirits have coagulated watery tinctures of the flowers of plants; ſome have weakened or deſtroyed the red colour of the tincture of daiſy flowers, whilſt others produced neither of theſe effects.

With Camphor.

Two ounces of the concentrated nitrous acid diſſolve one ounce of Camphor, the Camphor imbibing the ſtronger acid, and forming with it an oil which floats on the ſurface of the more phlegmatic liquor. Silver added to this ſolution throws out the Camphor, the acid diſſolving the Silver in its place.

Deflagration.

If the nitrous acid be combined with any ſubſtance whatever, that will detain it in the fire ſo as to receive a red heat; on the contact of any inflammable matter in that ſtate it either explodes or deflagrates, that is, burns and flaſhes with a hiſſing noiſe. All inflammable ſubſtances, as bones, hair, *&c.* and metallic bodies that abound with phlogiſton, occaſion a detonation with this acid, whether added to combinations of it in the fire or diſſolved in the pure acid, and after evaporation urged with a conſiderable heat. The acid is deſtroyed or diſſipated during the deflagration.

ARTICLE II.

Combination of the nitrous acid with metallic bodies.

With metallic ſubſtances.

THE nitrous acid diſſolves or corrodes all metallic bodies except Gold; and this alſo it is enabled to diſſolve by a ſmall admixture of marine acid. Silver, Copper, Iron, Lead, Quickſilver, Biſmuth and Zinc, are more readily and violently acted upon by this than by any other acid: With Copper it forms a green, with Iron a reddiſh, with Lead a yellow, with the others, colourleſs liquors. Tin it diſſolves imperfectly, and Regulus of Antimony it only corrodes into a powder.

Its action on moſt metallic bodies, unleſs the metal is cautiouſly added by little and little at a time, is accompanied with a conſiderable heat, effervescence, and a copious diſcharge of red fumes, which are found to be the ſtronger and more ſubtile part of the acid. Its action is moſt vehement on thoſe metals which

abſorb the aqueous humidity of the nitrous, and thus reduce it to a greater degree of concentration or ſtrength than it can be brought to by itſelf. The other mineral acids raiſe an effervescence and heat with oils, but the nitrous is the only one that produces actual flame with them.

The nitrous acid mixed with powdered ice, remarkably increaſes its coldneſs: The marine acid has this effect in a ſomewhat leſs degree, whilſt the vitriolic produces heat with ice.

which appearently contain moſt inflammable matter, as Zinc and Iron: Calces and croci, or metallic bodies deprived of their phlogiſtic principle it has no effect on. The ſolutions made with it are in general of a bitter and very nauſeous taſte. NITROUS ACID.

If Silver be diſſolved in this acid and Mercury added to the ſolution, the acid will depoſite the Silver, and diſſolve the Mercury in its place. If Lead be added to the mercurial ſolution the Mercury will fall, and the Lead be diſſolved. The Lead in its turn will be thrown down by Copper, the Copper by Iron, and the Iron by Zinc. Volatile alcaline Salts abſorb the acid from all the metals, and fixt alcalies from the volatile. The nitrous acid diſlodges the marine from ſome of the metals, as Regulus of Antimony, but the marine diſunites the nitrous from Mercury and Silver. General affinities.

ARTICLE III.

Combination of the nitrous acid with alcaline Salts.

THE nitrous acid ſaturated with volatile alcalies, forms with them a neutral ammoniacal Salt, which ſeparated from the watery phlegm by cryſtallization, is found to differ remarkably from the other Salts of this kind, in being perfectly diſſoluble in highly rectified Spirit of Wine; and in deflagrating when conderably heated, without any addition, eſpecially if the volatile Alcali employed was an oily animal ſpirit: From this property it received the name of *Nitrum flammans*. This acid forms with the alcaline baſis of Sea-ſalt a neutral Salt which ſhoots into cubical cryſtals, and hence called *Nitrum cubicum*. With vegetable fixed alcalies it cryſtallizes into long hexangular priſms, the common Nitre of the ſhops. With alcalies.

NITRE *or* SALTPETRE.

THE *Nitrum* or *Natrum* of the ancients, which was a natural production, appears from the ſeveral accounts given of it, to have been very different from our Nitre. The ſpecimens I have ſeen diſcovered nothing of the peculiar properties of Nitre or its acid, and were no other than Sea-ſalt mixed with a little Alcali, and ſometimes Sal ammoniac and Borax. NITRE. Of the ancients.

Nature affords no perfect Saltpetre: The accounts given by Boerhaave, Lemery and others, of Nitre being found native in the Eaſt-Indies, of its lying on the ſurface of the ground in open fields ſo as to be ſwept up by brooms, are neither ſupported by any good authority nor conſiſtent with the properties of Saltpetre. This Salt at the time of its firſt production is ſo volatile, that in open fields in thoſe warm climates, the ſun's heat would diſſipate it: How can it ſtand the rains on the ſurface of the open ground? Whence does it receive the vegetable Alcali, which is the baſis of Nitre, and which does not exiſt in the mineral kingdom? We may be aſſured that cryſtalline Nitre, from the Indies, or whence ſoever it comes, has been manufactured by art; that art has ſupplied its alcaline baſis and reduced it into a cryſtalline form. The acid is produced by a natural proceſs, putrefaction; but the Alcali is a creature of True Nitre never native.

art

NITRE. art alone: We ſometimes meet with efflorescences of earthy matters impregnated with the nitrous acid, but very different from true Nitre, and commonly diſtinguiſhed by the names of *Nitrum calcareum*, *Nitrum murarium*, *Aphronitrum*, and *Halinitrum*.

Exiſts not in waters or in the air.

Many have affirmed that a perfect Nitre exiſts in waters, and in the atmoſphere; but experiment diſcovers no ſuch Salt in either. In waters the Sal mirabile, or bitter purging Salt, has been miſtaken for Nitre, from its ſhooting into cryſtals of a ſimilar figure. That thunder and lightening proceed from Nitre is a groundleſs preſumption; and that the firing of gunpowder can impregnate the air with Nitre is apparently falſe; the diſtinguiſhing principle of the Nitre in the compoſition of gunpowder is deſtroyed in the exploſion.

Its production.

For the production of the nitrous acid are requiſite (1.) putrid or putreſcible matters, either of the animal or vegetable kingdom; (2.) certain earths, as lean Clays, Lime-ſtone, Gypſum, the rubbiſh of old buildings, *&c.* and (3.) air. The putrifying matters afford an oily urinous Salt: The uſe of the earths ſeems to be to imbibe and retain this Salt, whilſt the air ſerves not only as a neceſſary inſtrument of putrefaction, but furniſhes its own vitriolic acid, which being intimately blended with the oily and urinous matter by means of heat and the motion of putrefaction, is at length converted into nitrous acid.

All animal and vegetable ſubſtances contribute to the production of Nitre, in ſo far as they are ſuſceptible of putrefaction. Animal ſubſtances as being moſt diſpoſed to putrefy, are for this uſe the moſt proper; and the ſoft and fluid parts more ſo than the ſolid or hard. The greateſt quantities of Saltpetre are produced from urine and dung, whoſe ſtrong tendency to putrefaction renders them preferable to any other matters. Some differences are obſerved in the excrements of different animals: Human urine, the urine of ſheep, goats, and horſes, and the dung of pigeons, are found to anſwer beſt. The leaves, flowers, ſtalks of vegetables, hay and ſtraw, ſaw-duſt, *&c*, are mixed in the compoſition, and contribute more or leſs to the effect according to their degree of putreſcibility. On theſe principles Nitre may be produced in all countries; and in many places very advantageous works might be eſtabliſhed if we were better acquainted with the manner of its production.

Nitrous ferments.

Certain earths may be diſpoſed to this proceſs, and improved ſo as to afford more and more Nitre by the admixture of different ſubſtances which may properly be called nitrous ferments. Lime appears to be particularly ſerviceable in this intention. The following compoſitions are proper. (1.) Lime, ſheeps dung, ſheeps urine, and common Salt. (2.) Lime, Salt, raſped horns and hoofs, cuttings of leather, and other refuſe animal ſubſtances. (3.) Human urine and Lime. (4.) Human urine, Lime, Salt, and pigeon's dung, and other like mixtures of Lime and Salt with animal matters. (5.) Compoſitions of vegetables and animals together, as bitter plants boiled in urine and poured on the earth. (6.) Tartar, Lime and urine. (7.) Lime, preſſings of grapes, and the liquor of dunghills. (8.) Wine lees, dunghill liquor, Lime and Salt. (9.) Tartar and Lime. (10.) Lime, Salt, dunghill liquor, and the matter remaining after the diſtillation of Spirit of Wine. (11.) Lime, Salt, urine, dung, and martial ſcoria. Theſe compoſitions may be varied, or others formed on the ſame plan, as different circumſtances may require or permit.

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A nitrous Salt is produced without much assistance from art, in places where putrefaction is going on, in grounds frequently trodden by cattle and impregnated with their excrements, where vegetables rot, about slaughter-houses, lay-stalls, and in burying-grounds, on old shady walls exposed to putrid vapours, as those of stables, pigeon-houses, privys, near dunghills, &c. The earths into which the putrid matter most readily insinuates itself for the production of Nitre, are rather of the lean than the fat clayie kind, as mud-walls, Lime-stones and other absorbent stones. Some of the Saltpetre-makers, when they have met with an earth fit for the purpose, spread it in the neighbourhood of putrifying matters, where it may receive the putrid vapours. NITRE. Where generated.

The earth is of no further use in this process than as a matrix to imbibe and retain the nitrous matter: It contributes no more to the production of Nitre than alcaline Salts to the production of the water which they attract from the atmosphere. Though Sea-salt promotes the process, it does not appear to furnish any material principle to the Nitre, and seems to be of no further use than as it hastens putrefaction. The aereal acid intimately blended with putrescent exhalations in the pores of spongy stones or earths, is so far as we can judge, the true parent of the nitrous acid.

The nitrous matter thus produced is by no means perfect Saltpetre. It is dissipated from the earths by the sun's heat; and hence Nitre-works are commonly made to face the North, and the largest quantities of nitrous matter are found on the North-sides of wall. It exhales upon strongly boiling the earths in water. Extracted by water it does not crystallize; the liquor gently evaporated leaves only an unctuous saline mass, which liquefies again in the air. With inflammable substances it deflagrates much more languidly than true Nitre. To convert this volatile or calcareous into a perfect Saltpetre, by substituting a pure fixed alcaline Salt to the impure volatile or earthy matter here combined with the acid, is the business of art. Imperfect Nitre.

In most of the German Nitre-works, a mixture of two parts of ashes of hard wood and three of Quick-lime is stratified with the nitrous earth, in large wooden casks, the cock at the bottom being kept clear from the earth by a basket or some straw placed round it. The vessel is filled up with hot water, the liquor after standing for some time drawn off, fresh water added, and this repeated so long as it extracts any saline taste. The elixated earth is exposed again for some years to the action of the air and putrid exhalations, and thus becomes again impregnated with Nitre. Some instead of intermixing the Lime and ashes with the earth, sprinkle an alcaline ley upon the earth before its elixation, or mix it with the ley drawn from the earth. In some places the nitrous ley of the very first running is so weak, that it is necessary to use it instead of water for a fresh tub of earth——The liquor is gently boiled down to a due consistence, and then set to crystallize, the scum which arises during the boiling being occasionally taken off. The workmen judge of the proper consistence for crystallization, by a little of the liquor poured on a cold Iron quickly congealing, and of its being sufficiently saturated with the alcaline addition, by the dry matter quickly deflagrating on a burning coal. The liquor which remains after the crystallization is further evaporated and set to shoot again: When nothing more will shoot, it is poured upon fresh nitrous earths, Extracted and made perfect.

NITRE. or employed for the preparation of Magnesia, of which hereafter——Trial has been made of alcaline Salts by themselves, and of Lime by itself; but neither of them succeeded so well as a mixture of the two, either for forming Nitre with the nitrous ley, or with the pure nitrous acid alone. Lime alone does not crystallize; with alcalies alone, the crystals prove smaller and of a sharper and less agreeable taste than when Lime is added.

Purification, &c. Saltpetre is at present prepared and refined in almost all countries, not only in the East-Indies, but in several parts of Europe, as Muscovy, Poland, Sweden, Denmark, England, France, Bohemia, Germany. The Nitre produced at different works differs in degree of purity; it has naturally an admixture of the Sea-salt employed in the compositions from which it is made: Oftentimes a quantity of Alum is fraudulently mixed. It is purified by solution in water, filtration and crystallization: The pure Nitre shoots first, the Sea-salt and other heterogeneous matters remaining dissolved: Some add to the solution a little alcaline ley or Quick-lime; others a small portion of Alum, which occasions the crystals to be larger. For fire-works the Nitre is dissolved in Vinegar, whose inflammable matter is supposed to promote the detonating power of the Nitre. In the arsenal at Paris, Saltpetre is refined to different degrees of purity: Of this manufacture a pretty full account is given by Lemery.

Marks of its purity. The purity of Saltpetre is commonly judged from the crystals being large and long, colourless, transparent, free from knots or protuberances, and from their crackling when held in the warm hand. Cubical crystals are a mark either of common Salt itself, or at least that the nitrous acid is combined with the Alcali of common Salt instead of a vegetable Alcali. Their crackling or flying about when laid on a burning coal is a more certain mark of Sea-salt, and their swelling up into blisters after burning, of Alum. Some require the Nitre to burn totally away, and look upon such as leaves any residuum to be impure; but the purest Nitre leaves always a residuum, though we seldom find much remaining upon the coal, greatest part of it sputtering about and running off. The purity is most satisfactorily determined by redissolving and crystallizing the Nitre, and comparing the first and last crystals together; and by examining what kind of spirit they afford.

General properties. Pure Nitre (1.) dissolves in less than seven times its weight of water. (2.) It has a cooling taste, and increases the coldness of water in its dissolution. (3.) It melts with a less degree of heat than most of the other Salts, and flows thin as water. (4.) It bears a melting heat for a considerable time without losing any of its acid, but at length parts with a little, as appears from its growing moist on exposure to the air, its alcaline principle now prevailing: The whole quantity of the acid however, can scarcely be expelled, or not without a very long continuance of intense fires with frequent alternations of cold. (5.) It does not take fire of itself how strongly soever it is heated, but immediately deflagrates on the contact of inflammable matter, whether vegetable, animal or mineral. (6.) It does not deflagrate with fluid substances till their aqueous part is evaporated. (7.) It deflagrates with the imperfect metals and semimetals, dissipates their phlogiston, and changes them into a calx. It is the true test of inflammable matters, extricating and burning with the inflammable principle wherever it is to be found. (8.) In the act of deflagration

gration the acid of the Nitre is deſtroyed; the vapours which exhale are uri- NITRE.
nous, and the matter which remains is the fixed alcaline Salt of the Nitre.
(9.) Inflammable ſubſtances are incapable of themſelves of burning without air: By the addition of Nitre they burn in vacuo. If the air, however, is ſo perfectly exhauſted as that the coaly matter will not catch the fire, the Nitre in ſuch caſe will not kindle it. (10.) Nitre froths up greatly in the fire on the admixture of fixed alcaline Salt or Borax, particularly the latter. (11.) In diſtillation its acid ariſes in deep red, garnet-coloured vapours. (12.) Though produced by putrefaction, it reſiſts putrefaction the moſt powerfully of all the Salts. It gives a red colour to animal fleſh.

The principal conſumption of Nitre is in the making of gunpowder, and in Uſes.
compoſitions for fire-works: For this laſt uſe, the workmen have a commodious method of reducing large quantities into a powder, called Saltpetre meal, by diſſolving it in a little water, evaporating the ſolution, and keeping the matter conſtantly ſtirring with a wooden ſpatula during the exſiccation. This Salt is employed alſo in the refining of metals, in dying, in the compoſition of coloured glaſſes, for heightening and calling forth latent colours, for preſerving proviſions, and ſundry other mechanical and œconomical uſes. The dungs Nitrous Salt
which improve the fertility of land, ſeem to produce that effect by virtue of in vegetables,
the nitrous matter generated from them by the air. Wherever we meet with a whence.
true nitrous Salt in vegetables, we may be ſure that the plant has grown in a rich dunged field, on nitrous walls, or other nitrous ſoils; for ſuch a Salt is by no means natural to vegetables, though not unfrequently found in them. In fields there are ſometimes lumps of dung left unſpread: The plants which grow on thoſe ſpots ſhall be impregnated with a nitrous Salt, whilſt others of the ſame kind, growing in an undunged part in their neighbourhood, ſhall have none. We often obſerve theſe differences in fumitory, tobacco, particularly its ſtalks, the plants which grow on walls and the thatch of houſes, &c.

There have been many preparations of Nitre contrived for medicinal uſe, but Medicinal
pure Nitre itſelf is preferable to them all, and has a better claim to the title of a preparations.
polychreſt Salt than any, either of its own preparations or of thoſe of other Salts. See Stahl's *Menſis martius*, *de uſu Nitri medico polychreſto*.

Some diſſolve Nitre in vegetable juices, infuſions or decoctions, and cry- Infuccated.
ſtallize it afreſh: The Nitre thus *infuccated* as it is called, is diſtinguiſhed by the name of the plant whoſe juice, &c. has been uſed; *Nitrum roſatum*, *violatum*, *papaveratum*, *hordeatum*, &c. Such preparations are at beſt unneceſſary; for if the Nitre is ſuppoſed to retain any thing of the vegetable, the advantage expected from thence may be obtained with greater certainty by exhibiting an infuſion or other ſuitable preparation of the vegetable along with the Nitre. When diſſolved in the juices of ſaline plants, as that of ſorrel, the Nitre will evidently retain a portion of the eſſential ſalt of the herb, and in this caſe is called *Nitrum eſſentificatum*: But here alſo it is ſurely more adviſable to mix the pure eſſential Salt with a certain determinate quantity of pure Nitre.

The *Nitrum cachecticum*, or *Nitrum chalybeatum*, is a mixture of Nitre, *Ar-* Chalybeated,
canum duplicatum, and Vitriol of Iron, diſſolved and cryſtallized together—
Nitrum nitratum, or *Draco fortificatus*, is made by adding Spirit of Nitre to a Nitrated.
ſolution of Nitre, in the proportion of about half an ounce of the ſpirit to an

NITRE. ounce of the Salt, or diſſolving the Salt in the acid ſpirit, and then cryſtallizing. Some cohobate the acid ſeveral times upon the Nitre——*Nitrum regeneratum*, or *Tartarus nitratus*, is prepared by ſaturating Spirit of Nitre with fixt alcaline Salt, and cryſtallizing the neutralized liquor. The Salt thus prepared is ſomewhat ſharper than common Nitre: Boiled for ſome time in a Tin veſſel it ſenſibly corrodes the Tin, an effect never obſerved from common Nitre: By the addition of Lime, or rediſſolution in Lime-water, it loſes this acrimony, and becomes indiſtinguiſhable from pure Nitre.

Regenerated.

Sal prunellæ. *Nitrum tabulatum*, *præparatum*, *ſulphuratum*, *Rotula nitri*, *Cryſtallus mineralis*, *Lapis* or *Sal prunellæ*, is made by melting a quantity of Nitre in a crucible, and injecting upon it, when in thin fuſion, ſome flowers of Sulphur, in the proportion of about a dram to an ounce of Nitre: When the deflagration is over, the fluid matter may be taken up with a tobacco-pipe or other like inſtrument, and dropt upon a Copper plate ſo as to form it into little cakes. The Sulphur ſhould be injected by a ſmall quantity at a time: Some uſe Sulphur in the maſs, and throw in a whole piece at once, but I have ſeen dangerous conſequences from this practice——In this proceſs, the acid of the Sulphur expells a part of that of the Nitre, and unites with a proportionable quantity of the Alcali into a vitriolated Tartar; ſo that the preparation is no other than a mixture of Nitre and vitriolated Tartar in uncertain proportions, different operators employing different quantities of Sulphur. Where a mixture of theſe Salts is wanted, the rational preſcriber will never direct ſuch a precarious compoſition, whilſt the two Salts are to be had ſeparately, and may be readily mixed together in ſuch proportions as he ſhall think fit.

Arcanum duplicatum. The *Arcanum duplicatum*, *Sal catholicum*, *ſapientiæ*, *antifebrile*, *de duobus*, *&c.* is compoſed of the Alcali of Nitre and the acid of Vitriol, remaining after the diſtillation of the nitrous ſpirit with Vitriol or its acid. (See page 205.) The alcaline baſis of Nitre differs from the common alcaline Salt made from Tartar, only in having a ſmall admixture of calcareous earth. We have formerly ſeen that the acid of Vitriol forms with this earth a concrete not diſſoluble in water, and which conſequently cannot be retained in the preparation; ſo that the *Arcanum duplicatum* appears from its compoſition, as well as from experiments made upon it, to be entirely the ſame with vitriolated Tartar.

Sal polychreſt. A combination of the Alcali of Nitre with the acid of Sulphur is commonly called, from ignorance of its real nature, *Sal polychreſtum*. This is prepared from equal parts of Nitre and flowers of Sulphur mixed together, injected by degrees into a red-hot crucible, kept in the fire for ſome time, when grown cold elixated with water, filtered, evaporated and cryſtallized. A Salt prepared in the ſame manner from equal parts of Nitre, Sulphur, and cryſtals of Tartar, is ſaid by Senac to be the Sal polychreſt of Seignette. Monſ. Petit has given ſeveral curious experiments of the vegetation or efflorescences of theſe kinds of Salts in their cryſtallization.

Antimoniated Nitre. The *Nitrum antimoniatum* or *Anodynum minerale*, is a neutral Salt obtained by cryſtallizing the firſt waſhings of diaphoretic Antimony (pag. 137). It is ſo extremely uncertain in quality, that the phyſician can never truſt to it, being ſometimes an *Arcanum duplicatum* or Sal polychreſt, ſometimes a mixture of that Salt with unchanged Nitre, impregnated more or leſs with the reguline

part

part of the Antimony. We may readily diſtinguiſh its containing Nitre, by its deflagrating on burning coals. This Nitre may be diſtinguiſhed from pure Nitre by grinding a little of it in a mortar with Alum or Vitriol, when the antimoniated Nitre will immediately yield a ſmell of Aqua fortis, which the common Nitre does not; or by diſſolving it in water, and adding ſtrong Spirit of Vitriol, which will precipitate a white reguline powder from the antimoniated Nitre, but throw down nothing from the pure. NITRE.

The *Nitrum fixum* is the fixt alcaline Salt of Nitre, freed from its acid by deflagration with inflammable matters, and purified by ſolution in water, filtration, and evaporation. As vegetable coals deflagrate with Nitre more readily and more freely than the moiſter animal fats or other like matters, thoſe are made choice of for this operation. Some melt the Nitre firſt in a crucible, and gradually inject upon it powdered Charcoal, till a freſh addition occaſions no further deflagration upon ſtirring the matter: Others invert the procedure, injecting the Nitre upon the ignited Charcoal; and others grind both the ingredients together, and inject the mixture into a red-hot crucible: This laſt method ſeems to be the beſt. The perfect alcalization of the Salt depends chiefly on the due proportion of the Charcoal to the Nitre; for if this is not hit, a part of the Nitre will remain unchanged. Three parts of Nitre are commonly directed to one of Charcoal; but if the Charcoal is good, ſix or ſeven parts of Nitre will not be more than ſufficient, and the Nitre will be more perfectly alcalized than if its proportion was leſs. It is very difficult to deſtroy the acid by one operation ſo effectually as that the remaining Salt ſhall not yield red nitrous vapours on the affuſion of Oil of Vitriol: Hence Hoffman was led to affirm, that fixt Nitre differs from the common fixed Alcalies. When fully alcalized, it is in all reſpects the ſame, and yields like them, not red but white fumes with the vitriolic acid. A part of the acid of the Nitre ſeems, in the deflagration, not to be diſſipated or volatilized, but fixed and converted into an Alcali: Sixteen ounces of pure cryſtalline Nitre conſiſt of about eight ounces of water, four ounces of pure acid, and four of Alcali: If this quantity of the Salt be deflagrated with three or four ounces of Charcoal, which ſcarcely yield four or five grains of Alcali, eight, ten, and if the operation is carefully performed, even twelve ounces of pure alcaline Salt will be obtained. Fixed Nitre.

Nitre deflagrated in the ſame manner with Tartar, is reduced likewiſe into an alcaline Salt, which here receives an addition from the Alcali furniſhed by the Tartar. When the Nitre and Tartar are taken in equal quantities, nearly all the Nitre is alcalized, and a white Salt remains, called extemporaneous Salt of Tartar: If the quantity of the Nitre is double to that of the Tartar, great part of the Nitre continues undeſtroyed: On the other hand, if the quantity of Tartar is double or treble to that of the Nitre, all the Nitre is deſtroyed or alcalized, but great part of the Tartar is converted only into a black coal, the Nitre being inſufficient to burn out all its inflammable matter. This laſt compound is the common reductive Flux for metals among the chemiſts, goldſmiths, aſſayers, *&c.* and diſtinguiſhed from its colour by the name of black flux: The coal of the Tartar ſupplies the inflammable principle neceſſary for the revival of metallic calces; and the Alcali furniſhed by the Nitre promotes Extemporaneous Salt of Tartar. Black flux.

NITRE. their fusion. Both the black Flux and the white Salt are commonly prepared, by grinding the Nitre and Tartar separately into powder, then mixing them together, and setting them on fire in an Iron mortar, without applying any other heat than that which arises from their own deflagration. It is remarkable in this process, that though both the ingredients separately yield an acid spirit, yet here no marks of acid are to be perceived, the vapour which exhales being of the urinous kind; and that though Tartar, when calcined by itself to whiteness, leaves on being dissolved in water a very considerable quantity of earth, yet when thus burnt white by Nitre it almost totally dissolves, leaving scarcely any earth at all. The elder Geoffroy seems to claim the discovery of a volatile urinous spirit being produced from Nitre and Tartar, in the French Memoirs for the year 1717; but the same observation was made by Stahl thirty years before.

Caustic Nitre. Nitre is alcalized likewise by deflagration with metallic substances: By the martial Regulus of Antimony it is rendered not only alcaline, but excessively caustic, whence its name *Nitrum causticum*. A like effect is produced also, but in a lower degree, by filings of Iron, by Tin, and other mineral substances, whose phlogiston is fixed or intimately combined in the composition of the subject. Schroder reports that Nitre is alcalized by Quick-lime, but on trial this did not happen. For preparing the *Nitrum causticum*, nothing more is required than to mix the Nitre and martial Regulus in fine powder, and cement them for a time together.

Magnesia alba. *Magnesia alba* (so called in distinction from the plain *Magnesia* or Manganese, which is employed in the making of Glass) is a white very subtile powder, prepared from the mother-ley, or the liquor which remains after the first crystallization of rough Nitre. It was introduced as a medicine about fifty years ago, by Count di Palma at Rome, and continued a very lucrative secret. Sundry other preparations different in colour, yellow, brown, and violet *Magnesia*, were likewise vended in opposition to it——This celebrated medicine appears to be no other than a calcareous earth impregnated with a minute portion of the nitrous and marine acids, and to have very little claim to the virtues commonly ascribed to it. That the mother-ley contains those acids is evident from its yielding, when exsiccated and distilled with Oil of Vitriol, an Aqua regis. The matter dissolved in them appears to be chiefly the Lime that had been added in the extraction of the Nitre: If an alcaline Salt has been employed for this purpose without Lime, no Magnesia will be obtainable from the mother-ley. If the mother-ley is inspissated to dryness, and then calcined, greatest part of the acids is expelled: On edulcorating the calx with water, the small portion of Nitre or Sea-salt that might have been retained is washed off, and little other is left than the mere calcareous earth: This is the celebrated Magnesia. If common Quick-lime, flaked, dried, and ground into fine powder, be moistened with a little Spirit of Salt and Spirit of Nitre, then calcined and edulcorated, the same Magnesia will be obtained as that produced from the mother-ley. Hoffman proposes a more expeditious and commodious method of preparing the Magnesia from the mother-ley than that above-mentioned, by precipitation with Oil of Vitriol, Oil of Tartar per deliquium, or

Spirit of Sal ammoniac; the Precipitates however, obtained by these three liquors, will not be entirely the same (*l*). NITRE.

The *Terra foliata nitri* is made from alcalized or fixed Nitre saturated with Vinegar, in the same manner as the *terra foliata tartari* from Salt of Tartar— The *Nitrum ammoniacale fixum* of Wedelius is prepared by injecting one part of powdered Sal ammoniac upon four of melted Nitre—A mixture of four ounces of Nitre, a dram and a half of Borax, a dram and a half of Sal ammoniac, and a scruple of flowers of Sulphur injected gradually into a red-hot crucible, is called *Nitrum antifebrile*. Terra foliata nitri, &c.

Having now gone through the solid preparations of Nitre we proceed to the fluid, the principal of which is the acid spirit. Nitre committed to distillation by itself flows in the retort like water, and does not give over any spirit. The ancient chemists, supposing the extrication of the acid to be prevented by the fusion of the Salt, mixed with it certain earthy matters to divide or discontinue its particles, and thus prevent its fusion. To one pound of Nitre they took six or eight pounds or more of red Bole or Loam, dissolved the Nitre in water, worked up the powdered earth with this solution, and formed the mixture into balls about the size of pigeons eggs: These were dried in a warm place, put into earthen retorts, and distilled in a reverberatory furnace. An acid spirit now arose, but commonly weak and in small quantity: On elixating the residuum with water, it was found that only a little of the Nitre had given out its acid, the greatest part being recoverable in its original form, and having suffered no resolution or separation of its principles. The Nitre thus recovered, distilled with fresh earth, yields more spirit; and the Nitre, which then remains unchanged, treated again in the same manner affords more, till the whole quantity of the Salt is thus resolved. The earth, on the other hand, which has once been used, though perfectly freed by water from all remains of the Salt, if mixed a second time with Nitre, will never extricate any more of its acid; a proof that the expulsion of the acid depends not upon the division or discontinuation of the Nitre, for the earth divides it now as effectually as at first, but on some particular matter in the earth, which it loses in the first operation. The white earths, as Chalk, Lime, calcined bones, tobacco-pipe clay, *&c.* extricate no acid from Nitre even on the first time of using. Spirit of Nitre.

Stahl was the first who discovered the true theory of this operation. All the earths which extricate the acid of Nitre contain vitriolic acid; and it is on this acid that the effect wholly depends. Hence Vitriol itself, as containing much more

(*l*) *Magnesia alba.*] Magnesia alba differs from calcareous earths in two remarkable properties. One is, that it is not convertible by fire into Quicklime, the true criterion of earths of the calcareous kind: The other, that it dissolves readily in the vitriolic acid, into a limpid, bitter, purgative liquor, whereas calcareous earths concrete with that acid into an insipid and indissoluble selenites, and all the other earths that dissolve in it form austere styptic compounds. As considerable quantities of Lime are mixed with nitrous earths previously to the elixation of the Nitre, the earth obtained from the mother-ley may often contain a portion of calcareous earth, or even consist almost wholly of that earth; whence probably our author was misled into the opinion of this earth being no other than the calcareous. The earth which makes the basis of the purging Salts of mineral waters, and the incinerated earths of vegetables, are a pure Magnesia. See page 190.

NITRE. more of the acid, is employed to far greater advantage. If equal parts of Nitre and of green Vitriol calcined to yellowneſs be committed to diſtillation, the whole of the nitrous acid will ariſe. It has been generally ſuppoſed, that the acid of the Vitriol comes over in this proceſs along with that of the Nitre; Aqua fortis. and hence the diſtilled ſpirit is called, not Spirit of Nitre, but Aqua fortis. This however is by no means the caſe, the ſpirit, if the ingredients have been duly proportioned, being purely nitrous: All the vitriolic acid remains united with the alcaline baſis of the Nitre, and forms therewith the neutral Salt called *Arcanum duplicatum*, or vitriolated Tartar. It is a diſtinguiſhing character of the vitriolic acid to diſlodge both the nitrous and marine from any kind of alcaline Salt, and to unite with Alcali in their place.

The makers of Aqua fortis in Holland uſe for the diſtilling veſſel a large Iron pot with an earthen head and receiver, and keep the receiver cool by a conſtant application of cold water——They commonly employ rough Saltpetre without purification; and as Saltpetre in this ſtate almoſt always participates of Sea-ſalt, the nitrous ſpirit receives from thence a proportionable admixture of marine acid. The Eaſt-India Saltpetre is ſeldom free from pepper corns, ſtraws and other vegetable matters, by which the Aqua fortis is further fouled. When uncalcined Vitriol is uſed, ſome part of its volatile phlegmatic acid, haſtily extricated at firſt, will ariſe without acting upon the Nitre; and if the Vitriol is taken in a larger proportion than the nitrous Alcali can ſaturate, a part of its concentrated acid will diſtil towards the end of the proceſs. Hence Aqua fortis as commonly prepared is very ſeldom pure, as is well known to the refiners, who ſeparate Silver from Gold by means of this acid——Pure Aqua fortis or Spirit of Nitre perfectly diſſolves Silver into a colourleſs tranſparent liquor: A moſt minute portion of the marine or vitriolic acids added to this ſolution, renders it milky, extricating a part of the Silver, which on ſtanding falls to the bottom along with the extraneous acid. Hence we are furniſhed with a ſure method of diſtinguiſhing whether Aqua fortis participates of thoſe acids, and of purifying it from them. A little ſolution of Silver made in the pure nitrous acid, is to be dropt into that which is to be examined: If any milkineſs or cloudineſs enſues, we may be certain that the Aqua fortis is impure: If on ſtanding till the milkineſs has ſubſided, another drop of the ſolution occaſions no freſh cloudineſs, we may be equally ſure that the impurities are now ſeparated. Solution of Mercury likewiſe precipitates the marine acid from Aqua fortis in the ſame manner. Theſe experiments are a further proof that perfect Aqua fortis, ſuch as will diſſolve Silver, is no other than a pure Spirit of Nitre, ſince the nitrous acid mixed with either of the others will not diſſolve it.

Some diſtil the nitrous ſpirit with Alum inſtead of Vitriol, taking two parts of burnt Alum to one of Saltpetre. Others have uſed the dilute acid ſpirits previouſly extracted from Vitriol or Alum: Of theſe, no proportions can be fixed as the ſpirits differ greatly in degree of ſtrength: If the nitrous ſpirit obtained by this means is found to participate of the vitriolic acid, it is purified by drawing it over again from a little freſh Nitre, which will retain that acid; if it proves too phlegmatic, it is concentrated by diſtillation without addition, the watery part ariſing firſt, and the ſtronger acid remaining behind. The Spirit

Spirit of Nitre prepared both by Alum and by the pure vitriolic acid, emits red fumes in the air like that obtained by means of Vitriol; a proof that these vapours are not owing, as Lemery ſuppoſes them to be, to a Sulphur imbibed from the Vitriol, or to any metallic impregnation. NITRE.

The ſtrongeſt Spirit of Nitre is obtained moſt commodiouſly by means of the concentrated Oil of Vitriol. Pure dry Nitre reduced into powder, is put into a tubulated retort placed in Sand, a large receiver cloſely luted on, and ſome Oil of Vitriol poured in by a little at a time, through the tube of the retort, which is to be cloſely ſtopt after each addition. A part of the nitrous acid will ariſe without the application of any heat: After the ſpontaneous vapours have ceaſed, the fire is to be augmented by degrees till nothing more will come over. This ſpirit is extremely ſtrong, ſubtile and volatile, and requires to be well ſecured from the air, otherwiſe its more active parts will ſoon be diſſipated. It is diſtinguiſhed by the names of *Spiritus nitri concentratus*, *Volatilis*, *Fumans*; *Glauberi*, from its inventor Glauber, though Boyle alſo claims the diſcovery; and *Flammificus* or *Inflammans*, from its ſetting ſome eſſential oils on fire when haſtily mixed with them. Hoffman has given ſome experiments of this kind in his *Obſervationes phyſico-chymicæ*; and the younger Geoffroy in the French Memoirs.

Five parts of powdered Nitre and three of powdered Sulphur, mixed together and injected by a little at a time into a tubulated retort furniſhed with a recipient, yield a mixed acid ſpirit, compoſed of the nitrous and vitriolic acids. This is called *Clyſſus*; and when Antimony is uſed inſtead of Sulphur, *Clyſſus antimonii*. They are both of them very inſignificant preparations, and not worth the making. The vitriolic acid may be ſeparated, and the ſpirit rendered purely nitrous by drawing it over from a little freſh Nitre. Clyſſus.

In all the foregoing diſtillations, the nitrous acid is expelled from its alcaline baſis by the more powerful vitriolic. There are methods of extricating the nitrous without the intervention of that acid: If Nitre and ſand be mixed together and urged with a ſtrong fire, the Alcali will let go the acid, unite with the ſand and melt with it into Glaſs. Arſenic alſo expells the acid of Saltpetre: The ſpirit obtained by means of this concrete differs ſurprizingly from all the others in an exceſſive degree of volatility, and a deep blue colour. See page 142. Nitrous ſpirit by vitrification. Blue ſpirit of Nitre.

CLASS III.

Marine acid and its combinations.

THE marine acid, ſo called from its being diffuſed through the waters of the ocean, and making a conſtituent part of the neutral Salt ſo plentifully extracted from them for culinary uſes, is ſuppoſed by the chemiſts to be an offspring of the primordial or vitriolic acid, and to conſiſt of that acid combined with an inflammable and a mercurial or arſenical principle. MARINE ACID.

This acid is ſtronger than any of thoſe of the vegetable or animal kingdom, but weaker than the vitriolic or the nitrous, diſlodging the former from alcaline Salts and earths, but being itſelf diſlodged from them by both the latter. General properties.

In

MARINE ACID.

In the moſt concentrated ſtate in which we can eaſily collect it from other bodies, it contains about ſeven drams of water to one of pure acid. It is in part diſſipated by the action of the air in pungent vapours, not of a red colour like thoſe of the nitrous acid, but white. It ariſes in diſtillation alſo in white fumes, which condenſe upon the ſides of the recipient in ſtriæ like Spirit of Wine.

ARTICLE I.

Combination of the marine acid with metallic bodies.

As a menſtruum of metals.

THE marine acid eaſily diſſolves Zinc, Iron, and Copper. It acts more difficultly on Tin, and ſcarcely acts at all in its liquid ſtate, though aſſiſted by a conſiderable heat, upon Silver, Mercury, Lead, or Regulus of Antimony. There are means, however, of combining it with all metallic bodies: Thus, when the pure acid is abſorbed from the phlegm by fixed alcaline Salts, and the phlegm evaporated, if the dry Salt be committed to the fire in a proper veſſel, with the addition of vitriolic acid, the marine acid will be extricated from the Alcali in highly concentrated vapours, by which all the metals except Gold are diſſolved or corroded. It diſſolves Gold by the aſſiſtance of the nitrous acid, in its liquid ſtate (*m*)——It diſſolves metallic bodies when calcined, or deprived of their phlogiſton by fire, in which ſtate the nitrous acid has no effect upon them. The metallic matter, from which the coloured earths and ſtones receive their colour, is likewiſe extracted by this acid.

Liqueſcibility of its combination with metals.

All the combinations of metals with this acid are eaſy of fuſion in the fire. There are few which concrete into a cryſtalline form: All but thoſe of Silver, Mercury and Lead, if exſiccated by heat, imbibe moiſture from the air, and run into a liquid ſtate. The compound which it forms with Silver is not diſſoluble in water; that with Lead is ſcarcely ſo, and with Mercury difficultly: With Regulus of Antimony it forms a butyraceous or liquid matter, from which the metallic part is ſeparated and thrown to the bottom upon diluting it with water. Its combinations with moſt of the other metallic ſubſtances are eaſy of ſolution, not only in water but in rectified Spirit of Wine.

Volatilizes metals.

The marine acid when combined with metals, very ſtrongly adheres to them, ſo as not to be expelled by any degree of fire: In a ſtrong fire, it either volatilizes or carries them through the crucible, but never parts from them without the intervention of ſome other matter. Gold itſelf is ſo far ſubtilized and volatilized by this acid, as to ſublime and diſtil over the helm. Silver and Lead are reduced by it into concretes fuſible as wax, ſemitranſparent as horn, and ſo volatile that by a moderate fire they may be all driven up the chimney. Biſmuth and Regulus of Antimony diſtil with it in a butyraceous form, and Tin in that of a fluid ſmoking ſpirit. Iron ſublimes with it into yellow flowers.

Though

(*m*) *Diſſolves Gold.*] The marine acid diſſolves Gold alſo without the aſſiſtance of any other acid. If the Gold is melted with Tin or other imperfect metals, and the mixture calcined, or if the Gold is reduced into the form of a calx, this acid by moderate digeſtion, will perfectly, though ſparingly, diſſolve it, and keep it permanently ſuſpended. See page 33.

Though the marine is weaker than either of the other mineral acids, it has a greater attraction to some of the metals, particularly the white ones, to most of which it discovers a particular affinity: Thus Silver, Mercury, Lead, it precipitates from their solutions made in other acids; but on Gold, Copper or Iron it has no such effect. MARINE ACID. Affinities with different metals.

The metals which it thus absorbs from every other acid, are not those to which it discovers the greatest appetite of union when no other acid intervenes: In this circumstance it will unite with Copper, Iron, or Zinc, in preference to any of the other metallic bodies. When combined with Mercury, if Silver be added to the compound and a moderate fire applied, it will let the Mercury go and corrode the Silver. If this compound be melted with Lead, the acid will be transferred into the Lead, and leave the Silver revived into its metallic form. It will quit the Lead for Regulus of Antimony or Tin; and either of these for Copper, which it dissolves into a green liquor. If Iron be added to this solution, the acid will let the Copper fall, and dissolve the Iron in its place; and in like manner it will part from the Iron to dissolve Zinc——Such are the general laws of its affinity; but there are circumstances in which it recedes from them. When Sea-salt and Vitriol of Iron are mixed together and committed to the fire, the vitriolic acid forced out from its metal by the heat, extricates the acid of the Sea-salt, and this last unites with the Iron which the other has forsaken: So far the general laws of affinity obtain. The exception is, that if Quicksilver be added to this mixture, the marine acid, instead of uniting with the Iron will unite with the Mercury; and yet, when combined with the Mercury, it will forsake that to unite with Iron. The event is the same when Vitriol of Copper is substituted to Vitriol of Iron, or Regulus of Antimony to Quicksilver.

ARTICLE II.

Combination of the marine acid with alcaline Salts.

I. COMMON SALT.

THE common alimentary Salt called emphatically *Salt* without any epithet, is supposed by some to be the *Sal indum* of the ancients: But the accounts which the ancients have given of the *Sal indum* are evidently repugnant to this opinion: They describe it as being in colour like Salt, and in taste sweet as honey; from whence it plainly appears to have been no other than our sugar, the name *Saccharum* or *Zuccharum* being of much later date. COMMON SALT.

Common Salt is found either dissolved in the water of the ocean, or in those of certain springs, or in a solid form in the bowels of the earth; whence the names *Sal marinum* or Sea-salt, *Sal fontanum* or spring Salt, and *Sal fossile* or fossile Salt: This last is called also, from its being found in hard transparent bright masses like Crystal, *Sal gemmæ*. All the sorts are entirely natural Salts, art doing no more than to extract them from the waters, or purify them from the heterogeneous matters with which they are intermixed; whilst Nitre, Alum, Different kinds.

COMMON SALT.

Common Vitriol, and other mineral Salts owe to art, in good meaſure, their original production.

which firſt produced.

It has been diſputed whether the ſea or the foſſile Salt were created firſt; ſome ſuppoſing the foſſile Salt to have proceeded from the ſea-water left in caverns of the earth at the time of the deluge; and others, that the ſea-water became ſaline only at that period, by diſſolving the foſſile Salt. It is probable that both ſorts were created in the beginning: The immenſe beds of rock Salt met with in the earth have no appearance of their having been left there by the evaporation of water: And on the other hand, that the ſea was originally ſaline may be judged from the Moſaic account of the creation; whales and other ſea fiſhes were created on the fifth day, and it is not to be ſuppoſed that theſe could ſubſiſt without Salt to the time of the flood.

Quantity of Salt in Sea-water.

Sea-water contains different proportions of Salt in different climates, not entirely, as ſome have imagined, from its being in ſome places more diluted than in others by freſh rivers running into it; but principally from the greater or leſs heat of the climate, and proportionable evaporation of the aqueous parts. A pound of ſea-water in the northern part of the Baltic, particularly in the *Sinus Bothnicus*, yields ſcarcely a quarter of an ounce of Salt: Further ſouth, from the mouth of the Elbe to Holland, and in the Britiſh channel, a pound yields an ounce: In the Mediterranean and Spaniſh ſeas, the ſame quantity of water holds two ounces, and probably, towards the Line, the proportion of Salt will be found greater. Boyle obſerves, that the water at the bottom of the ſea is more ſaline than at the ſurface.

Bay Salt, where and how prepared.

The beſt Sea-ſalt and the greateſt quantities, are prepared in Spain and Portugal, as at Almahada, near Cadiz, St. Lucar, Malaga, St. Ubes. Conſiderable quantities are made alſo in France, and the Engliſh have attempted to eſtabliſh a Salt-work at Minorca. The general method of ſeparating the Salt is by evaporating the water; and the advantageouſneſs of the manufacture depends upon the effecting of this without the expence of fuel. For this purpoſe, choice is made of a clayie ground near the ſhore, ſo ſituated as that the ſea-water may be occaſionally let in or out by proper canals and ſluices: The ground being overflowed in the beginning of ſummer, to a ſmall depth, the water gradually exhales by the heat of the ſun, and leaves the Salt behind in a cryſtalline form. An account of the Salt-works in France may be ſeen in Lemery (*n*). The impure blackiſh-grey Salt thus obtained is exported from Spain and

(*n*) *Salt from the evaporation of ſea-water by the ſun's heat.*] Dr. Brownrigg propoſes a ſimilar proceſs in the Britiſh dominions. He ſhews, that commonly almoſt twice as much water falls annually on the weſtern as on the eaſtern coaſts of England; that in Lancaſhire, there does not fall in May, June, July, and Auguſt, above one third the quantity that falls during the reſt of the year; that in theſe months, at leaſt thirty inches will exhale, and only ten inches fall; that in exceeding hot weather, an inch will evaporate in twenty-four hours; that on the evaporation of ſixteen inches of ſea-water, there will remain one hundred and twenty-eight grains of Salt on every ſquare inch, and 104544 pounds on an acre. He directs the ponds to be made in a row from Eaſt to Weſt, and fitted with covers of ſail-cloth ſtretched on frames and painted white: Theſe ſerve both to keep out rain, and in dry weather to reflect the ſun's heat. The brine in the firſt large reſervoir may be occaſionally forced up by a fire engine, with a di-

and Portugal, to England, Holland, Sweden, and many other parts of the world, under the name of Bay-ſalt: This is refined by the Engliſh and Dutch, by ſolution in a little water, clarification commonly with ſome oxe's blood, and evaporation continued till the Salt forms into grains: In this refined ſtate likewiſe it proves an article of extenſive commerce. The Salt made in France is conſumed chiefly in France itſelf, and without purification, ſuch an extravagant duty being laid upon it, that people of middling circumſtances cannot afford a refined Salt. COMMON SALT.

The more northern nations, Denmark, Norway, Sweden, &c. where the ſun's heat is inſufficient for the preparation of Sea-ſalt by the method above-mentioned, might avail themſelves of their natural cold, by which greateſt part of the ſuperfluous water will freeze, leaving a ſaturated ſaline ſolution, from which the Salt may be ſeparated with little expence of fire. Sea-water concentrated by cold.

The point in view in theſe operations, is, to diſſipate the water and preſerve the Salt: It were to be wiſhed we could equally ſeparate the Salt and preſerve the

a diverger, to make it fall in drops. The expence of this apparatus, he obſerves, will be much leſs than that of the common ſaltern, excluſive of the fuel, which often coſts more than two-thirds the value of the Salt.

At Lemington, ſea-water is concentrated by the ſun's heat ſo advantageouſly, that though afterwards boiled with Newcaſtle coal, the Salt can be afforded cheaper than that made in the neighbourhood of Newcaſtle itſelf, where the fuel is not above one fourth the price.

Salt from ſea-water by fire.] The brine is boiled down in large pans made of Iron plates, joined with nails, and cemented with Lime. From a pan of about 1305 gallons are drawn every day fifteen or twenty buſhels of Salt, each buſhel containing fifty-ſix pounds. In Northumberland and Durham there are upwards of two hundred pans at work, in which are annually prepared eleven or twelve thouſand tuns of Salt.

To the brine juſt warm are added the whites of three eggs, or a little ox blood, mixed with two or three gallons of ſea-water. As the heat increaſes, a black ſcum ariſes, which is raked off, and the liquor now perfectly clear, kept ſtrongly boiling: An earth called ſcratch, ſubſides into ſmall pans placed for that purpoſe in the corners of the boilers, where the motion is moſt gentle. When cryſtals begin to form on the ſurface, the pan is filled up, clarified afreſh, and this repeated four times. When the Salt now begins to cryſtallize, the fire is ſlackened, and the liquor kept only ſimmering during the granulation. After the Sea-ſalt has cryſtallized, a bitter liquor remains, which on further evaporation yields the bitter purging Salt, page 189.

Common Salt has one remarkable property, in which it differs from all the other neutral Salts. It diſſolves almoſt as plentifully in cold as in hot water; if water be fully ſaturated with it when boiling hot, ſcarcely any of the Salt ſeparates or cryſtallizes upon the liquor's growing cold. The Salt concretes only in proportion as the water evaporates, and hence the neceſſity of keeping up the heat during the whole time of the cryſtallization.... If the proceſs is too long continued, the bitter Salt cryſtallizes along with the culinary Salt. We ſeldom meet with any Sea-ſalt entirely free from the bitter one: Hence the earthy matter, which ſolutions of Sea-ſalt depoſite upon the addition of alcalies, and which ſome have erroneouſly looked upon as one of the conſtituent parts of the Sea-ſalt itſelf.

There is another ſingular property of common Salt, its parting with a conſiderable quantity of its acid, on boiling down, whether in open or cloſe veſſels, a ſaturated ſolution of it to dryneſs. Hence the acid which ariſes in the diſtillation of ſea-water, eſpecially towards the end of the proceſs; and hence the alcaleſcent quality of Sea-ſalt cryſtallized by too ſtrong a heat, its diſpoſition to liquefy in the air, its weakneſs and unfitneſs for preſerving proviſions.

COMMON SALT. the water, ſo as to obtain from the ſea a ſweet water, fit for drinking and the other uſes of life. Sundry methods have been propoſed for this purpoſe, but none have hitherto fully ſucceeded: I have ſeen many machines and models of machines, which anſwered in ſome reſpects, but failed in others. See *Water*.

Bittern. The mother-ley of Sea-ſalt, or the liquor which remains after the purification and cryſtallization, is employed in England for making a purging bitter Salt, which proves ſimilar in quality to the Salt obtained from the Epſom waters, and is commonly ſold under its name. The ley is boiled down to a certain pitch, then filtered and inſpiſſated, the dry matter calcined, rediſſolved, and cryſtallized. (See page 189.) If the mother-ley be inſpiſſated, and diſtilled with vitriolic additions, a Spirit of Salt is obtained.

Sal gem. The foſſile Salt or Sal gem is found in ſeveral parts of Europe, as in Poland, in Spain, particularly in Catalonia, in Muſcovy, in Calabria, in Tranſylvania, and at Stower in the upper Hungary. Some of theſe Salt mines are of amazing magnitude: The ſingle mine of Cracow in Poland, near Wielizka and Bochna, is computed to hold Salt enough to ſuffice the whole world for many thouſand years. There are houſes, chapels, *&c.* under ground, all built of Salt or the Salt ſtones. The foſſil is cut and turned into pillars, altars, crucifixes, images, *&c.* oftentimes it is naturally cryſtallized into very curious figures. Maſſes are brought up to day, weighing from twenty to thirty hundred weight. The pure ſaline maſſes are called *Stone-ſalt*, the harder and more ſtony, *Salt-ſtones*. Pieces of theſe laſt are commonly put into cow-ſtalls for the cattle to lick, as they hold longer than the Salt. In Poland, Tranſylvania and Hungary, the mineral is commonly white or greyiſh: In Catalonia, it is often reddiſh, bluiſh, and of various other colours. The pure cryſtalline pieces are employed for the common purpoſes of Salt in their natural ſtate: The more impure and crumbly are purified by ſolution in water, filtration and cryſtallization: They do not now concrete into maſſes of the original ſize, though the cryſtals are ſomewhat larger than thoſe of ſea or Spring-ſalt.

Spring-ſalt. The Spring-ſalt is the ſort generally made uſe of among us, and underſtood by the name common Salt. The Salt ſprings of different countries are impregnated with different proportions of Salt, and the Salt itſelf differs alſo in degree of ſtrength. The brine at Halle is one of the richeſt in Germany; a pound of this contains three ounces and three drams of Salt, while ſeveral others hold ſcarcely a quarter of an ounce upon a pound (*o*). On the other hand the Luneburg and Hartzeburg Salt, and ſome others, are ſtronger and better, and ſhoot into larger cryſtals than that of Halle. An account of the ſalt-works at Halle may be ſeen in Hoffman's obſervations; and an account of moſt, if not all the places in Europe where Salt is boiled, or foſſile Salt dug, in the Breſlau collections.

In

(*o*) *Quantity of Salt in ſaline ſprings.*] Several brine-pits in England are richer in Salt than thoſe above-mentioned. Thoſe of Droitwich contain four ounces on ſixteen; and ſeveral pits at Northwich, and at Barton in Lancaſhire, no leſs than ſix upon ſixteen; which is as large a proportion of Salt as water will diſſolve. The Droitwich brine is ſaid to be pure from ſcratch, and ſcarce to hold any bittern, whilſt all others contain both.

In the boiling of the brine, ſome oxes blood is commonly added to promote the ſeparation of the impurities, which ariſe with the blood to the ſurface of the liquor, and are thence ſcummed off: Some beer is added to promote the granulation or cryſtallization of the Salt: Wine anſwers the ſame purpoſe, and rectified Spirit of Wine ſtill more effectually. The cryſtals are firſt formed on the ſurface, but growing gradually larger from the accretion of freſh matter, they ſink to the bottom, from whence they are taken up with wooden inſtruments, and put in baſkets to drain. COMMON SALT.

In ſome places where the brine is ſo dilute that the quantity of Salt would not pay the expence of fuel neceſſary for the evaporation, and where neither the ſun's heat nor froſt can be applied to advantage, a method has been contrived of concentrating the liquor, or diſſipating great part of the ſuperfluous water, by means of air and wind: Large buildings are erected open every way to the air, with ciſterns and channels, where the brine is conſtantly dripping, or falling in ſlender ſtreams, through bundles of ſtraw, horſe hair, faggots, &c. A part of the water being thus carried off, the reſt is evaporated by fire. There are works of this kind at Nauenheim near Francfort, at Saltzungen, Aſcherſleben, Allendorff, Saltza, Hellen, Saltzgutter, near Lutzen in Merſeburg, near Colberg in Pomerania, and in ſeveral other places. The proceſs however is not a little troubleſome and incommodious. The ſtrength of the brine is judged of by the hydrometer, or by weighing equal meaſures of the brine and of common water. Diſtillation, rediſſolution, and cryſtallization are the ſureſt teſts, but require too much time and trouble to be practiſed at the works. Concentration of ſaline water by air.

Pure common Salt diſſolves eaſily in leſs than thrice its quantity of water, into a clear colourleſs liquor, which depoſites no ſediment: On gentle evaporation the Salt concretes into cubical cryſtals, hollow at top, pointed at bottom, hard, compact, colourleſs, and tranſparent: The ſoft, crumbly kinds, and ſuch as grow moiſt in the air, are inferior in ſtrength to the ſolid. Laid on burning coals, it crackles, burſts in pieces and flies about, increaſes the flame, and is in part diſſipated. It eaſily melts, and at the ſame time loſes a little of its acid, the Alcali being now found to prevail ſo much, that the Salt liquefies in the air. It is eaſily volatilized by fire, and by putrefaction along with ſubſtances diſpoſed to that proceſs. By repeated ſolutions and calcinations, it may be totally deſtroyed or converted into earth: By thirteen repetitions of theſe operations, a pound of Salt was reduced to half an ounce, the earth amounting to three drams, and the Salt that remained unchanged only to one. Chemical properties of common Salt.

The three ſorts of common Salt appear when perfectly pure, to be one and the ſame, but in their common ſtate ſome little differences may be obſerved in them. The ſea and Spring-ſalts never ſhoot into ſuch large and ſolid cryſtals as the Sal gem: The cryſtals of the Spring-ſalt are the ſmalleſt of the three, and likewiſe the weakeſt. Sea-ſalt frequently contains a little nitrous matter, produced from the putrefaction of vegetable or animal ſubſtances in the ſea; hence the acid ſpirit extracted from it is ſometimes obſerved to diſſolve Gold, which the marine acid is incapable of doing without the aſſiſtance of the nitrous. Alcaline Salts added to a ſolution of the ſea or Spring-ſalts, render Differences of ſea, brine, and foſſile Salts.

the

COMMON SALT. the liquor turbid or milky, and precipitate an earthy matter, amounting to about ten grains from an ounce of Sea-ſalt, and twelve grains from the ſame quantity of Spring-ſalt; added to a ſolution of Sal gem, they occaſion no precipitation or turbidneſs.

Spirit of Salt, different methods of diſtilling. The acid of common Salt is extracted in the ſame manner as that of Nitre, either by the addition of a more powerful acid, which may diſlodge it from its fixed alcaline baſis, or of vitreſcible earths, as ſand, with which in a ſtrong fire, the Alcali melts into Glaſs, letting go its acid. The firſt of theſe methods is the only one practiſed, the latter being extremely troubleſome and incommodious. Both the vitriolic and the nitrous acids expel the acid of common Salt: The firſt is preferred, as being the moſt powerful, and as a part of the nitrous acid would ariſe along with the marine, and thus inſtead of a pure ſpirit of Salt, produce an Aqua regia.

The old method of diſtilling ſpirit of Salt was with red Bole, ruddle, or other coloured bolar earths: Theſe were moiſtened with a ſtrong ſolution of the Salt into the conſiſtence of a paſte, then formed into little balls, the balls dried and diſtilled in earthen retorts: The ſpirit thus obtained was in ſmall quantity, and very phlegmatic. It was endeavoured to be freed from the redundant phlegm by rectification, or rediſtillation in glaſs retorts; but the great volatility of the marine acid renders it incapable of being concentrated to any conſiderable degree by this method, the acid vapours ariſing in part along with the water.

The earths in the foregoing proceſs, as in the diſtillation of Spirit of Nitre, were of no further uſe than as they were impregnated with vitriolic acid; and hence ſubſtances participating more largely of that acid were employed to much greater advantage. Calcined Vitriol readily and effectually extricates the acid of the common Salt, but one of the peculiar qualities of the marine acid renders it an improper addition; this acid, when diſunited from its own alcaline baſis, adhering ſo ſtrongly to the metallic part of the Vitriol, as ſcarce to be elevated in diſtillation. Alum is free from this inconvenience: The common Salt may be mixed with thrice its weight of Alum moderately burnt, and the mixture committed to diſtillation in glaſs retorts in an open fire: The diſtilled ſpirit may be drawn over from a little freſh common Salt, which will abſorb and keep down any of the aluminous or vitriolic acid that may have ariſen in the firſt diſtillation. But the marine ſpirit is moſt ſpeedily and effectually ſeparated by oil of Vitriol itſelf; and the ſpirit obtained by this means is the ſtrongeſt and moſt concentrated: It is ſo ſubtile and volatile, that its vapours will ſcarce condenſe in the recipient, and can ſcarce be confined by any luting, its ſmell being diffuſed throughout the whole elaboratory: Hence it is adviſable to place in the recipient ſome ſpirit of Salt already made, with which the fumes may incorporate. The moſt commodious method of performing the proceſs, is to put the Salt firſt into a tubulated retort, and drop in the oil of Vitriol through the aperture of the tube by a little at a time: If much of the Oil was poured in at once, the fumes would ariſe ſo haſtily and copiouſly as to endanger ſuffocating the operator; and if poured in by the mouth of the retort, it would be apt to foul the neck. In all the diſtillations, the ſudden ceſſation of the white clouds, or the receiver growing clear before the ſpirit has come over, are marks that the retort has cracked.

Spirit

Spirit of Salt has been employed by ſome for cleaning and whitening the teeth. A French prieſt, father de Cabriere, gave it in ruptures, and vended it as an extraordinary panacea, to the prejudice of the health of many, eſpecially of thoſe who had weak lungs. An empyric, Mœbius, vended a liquor by the name of *Tinctura aperitiva*, which, as Hoffman and Barchuyſen aſſure us, was no other than ſpirit of Salt, tinged with turnſol or roſes, and abated a little of its acidity by a ſmall admixture of Salt of Tartar: The quantity of the alcaline Salt is ſaid to be only half a dram, or at moſt a dram, to a pound of the ſpirit of Salt; a notable arcanum truly! Spirit of Salt in its corroſive ſtate, is by no means fit for internal uſe.

COMMON SALT. Uſe of Spirit of Salt.

This acid is dulcified like the other mineral acids, by Spirit of Wine. One part of Spirit of Salt is commonly mixed with three parts of highly rectified Spirit of Wine, the mixture digeſted and diſtilled: But as ordinary Spirit of Salt is very phlegmatic, and as phlegmatic acids are unfit for dulcification, we ſeldom meet with a good dulcified Spirit of Salt in the ſhops. The beſt method of obtaining ſuch a ſpirit is, to place the Spirit of Wine in the receiver, in the diſtillation of the ſmoking Spirit of Salt with Oil of Vitriol: By this means we obtain a mixture of the concentrated marine acid with the inflammable ſpirit, which are afterwards to be more perfectly combined together by digeſtion and diſtillation. Three or four ounces of the vinous ſpirit may be taken to every ounce of common Salt.

Dulcified Spirit of Salt.

Spirit of Salt ſaturated with Salt of Tartar, yields on cryſtallization a neutral Salt called regenerated Sea-ſalt. This is of a ſharper taſte than common Salt itſelf, and differs from it in ſome other reſpects, the alcaline baſis of common Salt being different from the alcaline Salt of Tartar, or any of the vegetable alcalies. When the nitrous acid is poured upon common Salt, the marine acid will be extricated, and readily diſſipated by heat, the nitrous remaining combined with the Alcali of the common Salt, with which it ſhoots into cubical cryſtals, whereas with the common vegetable alcalies it forms long hexangular priſms. Oil of Vitriol combined in like manner with the marine Alcali, forms a neutral Salt which eaſily diſſolves in water, and eaſily melts in the fire, called by its inventor Glauber, *Sal mirabile*; whilſt a Salt compoſed of the ſame acid and vegetable alcalies is extremely difficult of ſolution, and does not melt at all. It muſt be obſerved however, that when the common alcalies have been ſaturated with Spirit of Salt, and this compound treated with oil of Vitriol; the neutral Salt hence reſulting, after the expulſion of the marine acid, will greatly reſemble the *Sal mirabile*.

Regenerated Sea-ſalt.

The marine acid is ſeparated and transferred into other bodies, in ſundry operations, where ſuch an effect is generally little thought of. Thus in the making of corroſive Sublimate, it is the acid of the Sea-ſalt that unites with the Mercury: And in the making of butter of Antimony, it is this acid which forſaking the Mercury corrodes the antimonial Regulus into a butyraceous form.

Tranſpoſitions of the acid.

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II. SAL AMMONIAC.

Its name. SAL AMMONIAC is a neutral Salt compoſed of the marine acid and volatile Alcali: Combinations of other acids with volatile Alcalies are called alſo from the name of this Salt ammoniacal. The name *Ammoniac* is derived by Salmaſius from one of the Cyrenaic territories, *Ammonia*; by others, from the temple of Jupiter Ammon in Africa; by others from the Greek ἄμμος ſand, or ἀμμωνιακὸν ſandy, the Salt being ſaid to have been found plentifully in Ammonia, and near Ammon's temple, in ſandy grounds.

Whether native. The Sal ammoniac of the ancients is commonly ſuppoſed to have been a ſpecies of Sal gem. The true modern Sal ammoniac is never found native, at leaſt not in any tolerably pure ſtate. The ſaline matters thrown out by Volcanos, and which are commonly ſaid to be Sal ammoniac, have often little or nothing of an ammoniacal nature. They are of various colours, red, green, yellow, and others: In ſome ſorts I have found a little volatile Alcali, but the greater number contained none: Some participated of the vitriolic acid, and ſome of the marine; ſome held an actual Sulphur, and ſome had a cupreous or ferrugineous impregnation.

Prepared in Egypt. Common Sal ammoniac is an artificial preparation, hitherto made only in Egypt. The principal manufacture is at two villages lying near together, about a mile from the city Menſoura in the province of Delta, called Damire or Dameyer. In theſe there are twenty-five large and ſeveral ſmaller works; and fifteen hundred or two thouſand quintals or hundred-weights of Sal ammoniac are prepared every year. There are three other works in Egypt, leſs conſiderable than the foregoing, two in the ſame province, and one at Cairo; in which laſt, the annual produce of Salt does not exceed twenty or thirty hundred weight. It is ſurprizing that means have not been found of preparing this commodity to advantage in Europe, as its conſtituent parts are perfectly known.

Enquiry into its preparation. The ingredients from which Sal ammoniac is produced have long been mentioned in books. Cæſalpinus, if I miſtake not, was the firſt who informed us, that this Salt is obtained from ſoot, urine and common Salt; and from theſe, it is ſtill affirmed that the Egyptian Sal ammoniac is made: The proportions commonly ſet down are, ten parts of urine, two of common Salt, and one of wood ſoot. There is however, in regard to theſe ingredients, a grand miſunderſtanding, which ſo far as I can learn, was firſt diſcovered by Paul Lucas (who travelled through Egypt and other parts of Africa) and afterwards confirmed in the year 1719, by the French conſul at Cairo, by father Sicard, and more lately by one Granger. The Egyptian ſoot is not the ſame with ours: It is the ſoot of animal dung, chiefly of that of cows; which is the common fuel of that country, either dried by itſelf or mixed with ſtraw. The urine employed in the making of Sal ammoniac, is that of horſes, aſſes, or camels; and as the ſoot abounds much more than ours with a volatile animal Salt, the urine alſo is richer in ſaline matter than that of the ſame animals in theſe colder climates.

Of the manner in which Sal ammoniac is made from the foregoing ingredients, we have not as yet ſo full an account as could be wiſhed. Two of the French chemiſts, the younger Geoffroy and the younger Lemery, diſputed for ſeveral years whether it was prepared by ſublimation or inſpiſſation: Geoffroy maintained the former, and Lemery the latter. Geoffroy gave one memoir on the ſubject in 1705, and another confirming his opinion in 1716; but the academy, either imagining that Lemery was in the right, or that both opinions were equally well founded, ſuppreſſed Geoffroy's memoir, till an account ſent by the conſul at Cairo convinced them that the Salt was made by ſublimation. This gentleman obſerves, that the ſubliming veſſels are made of earth or glaſs, of a globular figure, generally a foot and a half in diameter, with a neck about two fingers high, like the common receivers; that forty or fifty pounds of the matter are put into one veſſel; that in every large elaboratory there are eight furnaces, and in every furnace ſixteen ſubliming veſſels; that the veſſel is left open for a time, till the phlegmatic parts have exhaled, and afterwards covered; and that the proceſs takes up three days and nights. This is all we know as yet of the manufacture of Sal ammoniac: Granger has made ſome additional obſervations, but they contribute nothing to the principal point. SAL AMMONIAC.

With regard to the ingredients, I am fully perſuaded, that urine, ſoot, and common Salt are not all. The common Salt would not part with its acid, and conſequently could be of no manner of uſe without the addition of Loam, Bole, or ſome of the other ſubſtances employed for the diſtillation of Spirit of Salt; and ſome ſuch addition is doubtleſs employed by the Egyptians, though it has eſcaped the notice of the gentlemen above-mentioned——If the preparation of Sal ammoniac is attempted in this country, we are not to be confined to urine and the ſoot of dung. This Salt conſiſts of marine acid and volatile Alcali: The acid may be obtained by proper intermedia from all the ſorts of common Salt, and all animal matters furniſh a volatile Alcali. Different animal ſubſtances yield different quantities of Alcali; and ſuch are to be made choice of for this uſe as yield the moſt, and are to be procured at the leaſt expence, as dung, urine, refuſe cuttings of leather, horn, bone, hoofs, hair, wool, *&c.*

With regard to the proceſs, I apprehend that both Geoffroy and Lemery are partly in the right, but neither of them entirely ſo. The production of the volatile Alcali, and its combination with the marine acid, are doubtleſs effected by ſublimation: But the form of the cakes in which Sal ammoniac is brought to us, appears to be procured by inſpiſſation. If we ſublime Sal ammoniac in the ſame kind of veſſels in which it is ſaid to be ſublimed at firſt, it will by no means concrete into cakes, nor does any Salt we know of aſſume ſuch a form by that proceſs: On the other hand, by ſoftening the powdered Salt with water into the conſiſtence of pap, and pouring it into ſuch a glaſs as is uſed for deliquiations, (having a ſmall aperture in the bottom for ſuffering the liquid part to drain off) I have obtained a cake exactly reſembling the Egyptian. The hemiſpherical ſide of the cake, and the prominence in the middle, which Geoffroy ſuppoſes to correſpond to the upper part of the ſubliming veſſel, were here formed by the bottom of the inſpiſſating veſſel. In the middle

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of the cakes of Sal ammoniac we find ſome manifeſt cryſtals; and the reſt of the maſs is throughout of ſuch an uniform and continued ſtructure, as could not have been produced by conſtant caſual appoſitions of freſh matter. The inſpiſſation appears to be performed by the Egyptians in glaſs veſſels, as we frequently find pieces of glaſs adhering to the cakes.

Cakes and loaves.

Two kinds of Sal ammoniac are diſtinguiſhed in trade, one in broad cakes, convex on one ſide and flat on the other, about two inches and a half or three inches thick; the other in large conical loaves, reſembling ſugar loaves and probably formed in the ſame kind of moulds. This laſt ſort is ſaid by ſome to be the produce of the Eaſt-Indies: It is very rarely met with among us; the firſt ſort, which is the moſt pure, being the only one in common uſe. The cakes are uſually blackiſh on the outſide, but internally white, ſemi-tranſparent, eſpecially about the edges, hard, compact, and in ſome degree ſonorous, of a ſharp taſte without any ſmell.

General properties.

Sal ammoniac diſſolves in four times its weight of water, and renders the liquor ſenſibly colder: The greateſt degree of cold hitherto produced in water by artificial mixture, without ice, reſults from a compoſition of Sal ammoniac, Mercury-ſublimate, and Vinegar. Several experiments of this kind, and of vegetations or curiouſly figured cryſtallizations of Sal ammoniac may be ſeen in the French Memoirs. It is ſaid, that a ſolution of Sal ammoniac wrote with on paper, on which it leaves no ſtain, will become viſible on expoſing the paper to the fire; and that paper or linen moiſtened with this ſolution will not burn. On trial the writing did not become legible when heated (*p*), and the paper impregnated with the Salt, burnt and conſumed, though it did not flame.

Sublimation.

Sal ammoniac proves totally volatile in a heat conſiderably below ignition, nearly in ſuch a degree of heat as Lead requires for its fuſion. If no other ſubſtance is added that may diſunite its conſtituent parts, it ſublimes unchanged. By repeated ſublimations however, it acquires at length a yellowiſh tinge, and a particular ſmell, of which it diſcovered nothing at firſt. Theſe alterations proceed from the oily or inflammable matter of the volatile animal Salt; for that Sal ammoniac participates of that principle, appears from its deflagration with Nitre. The detonation is moſt obſervable when four parts of Nitre are mixed with one of the Sal ammoniac; a mixture of three parts with one deflagrate but weakly, and two with one, not at all.

Deflagrates with Nitre.

Volatilizes metals.

This Salt remarkably opens and volatilizes metallic bodies, eſpecially if they have been previouſly reduced into calces or precipitates; even the moſt fixed of all known ſubſtances, Gold, may be forced over the helm by means of Sal ammoniac: Regulus of Antimony is ſo attenuated by it, as to diſſolve in Vinegar, if not in water. By repeated ſublimations, both the Salt itſelf, and combinations of it with other bodies, become leſs and leſs volatile. Pure Sal ammoniac after a number of ſublimations, proves at length ſo fixed as to remain half fluid in the bottom of the ſubliming veſſel. On ſubliming Mercury-

Made fixed.

(*p*) *Characters drawn with ſolution of Sal ammoniac not legible when heated.*] They do not become viſible by being moderately heated; but if the heat is ſuch as to ſlightly ſcorch the paper, the part impregnated with the ſaline ſolution will be burnt black, whilſt the reſt is ſcarcely brown.

cury-ſublimate with Sal ammoniac, mixing the matter which aroſe with the reſiduum, and repeating the operation ſeveral times, the matter at laſt became quite fixed in the fire, and would no longer riſe from the bottom of the glaſs. On ſubliming together a mixture of Sal ammoniac, Mercury, and Sulphur, there remains every time a little fixed browniſh-red matter, which bears a conſiderable melting heat, and is called by ſome fixed Cinnabar. SAL AMMONIAC.

Sal ammoniac is made uſe of in ſundry mechanic buſineſſes, by the dyers, glaſs-makers, but more particularly by thoſe who work upon metals, for ſoldering, *&c.* Gold is taken off from gilt Silver, by heating the veſſel red-hot, and quenching it in a ſolution of a pound of Borax, a pound of Tartar, and an ounce and two drams of Sal ammoniac——As a medicine, it is accounted powerfully antiſeptic, aperient, diuretic and diaphoretic. A doſe of half a dram, or a dram, is recommended in quartan agues; and ſaid, if it fails the firſt time, to cure with certainty on repeating it: Experience has ſhown, that it is a medicine of remarkable efficacy in agues, though it does not in all caſes ſucceed. Given too frequently, or in too large doſes, it is ſaid to injure the ſtomach and chill the habit. Externally it is employed againſt films on the eyes of cattle, in gargariſms for quinſeys, in applications for gangrenes, for reſolving ſwellings and nodes in the breaſts, when not of long ſtanding or accompanied with inflammation, and for other like purpoſes. An ointment againſt nodes and ſoft excreſcences is compoſed of ſix ounces of Sal ammoniac, three drams of Ceruſſe, one dram of Camphor, and a proper quantity of Oil of Roſes. Uſes.

The moſt ſimple preparation of Sal ammoniac is its purification. This is effected either by ſolution in water, filtration and cryſtallization, or by ſublimation. The firſt method is greatly to be preferred; for ſublimation ſeparates only the ſand, bits of glaſs, or other like groſs ſubſtances that have been caſually mingled with the Salt, the ſooty and oily impurities ſubliming along with it. By ſublimation alſo the inflammable principle of the Sal ammoniac more and more diſcovers itſelf, and communicates both a colour and ſmell to the Salt. By ſolution and cryſtallization it is effectually purified from all the ſubſtances commonly mixed with it, that are not eſſential to its compoſition. Some ſublime the Sal ammoniac from common Salt: This addition ſomewhat varies its quality, eſpecially if the ſublimation is ſeveral times repeated, a portion of the volatile acid of the common Salt being imbibed by the Sal ammoniac. Purification.

The *martial flowers* of Sal ammoniac are prepared commonly from one part of Iron filings or *Lapis hæmatites* and two of the Salt, mixed well together, ſet by for ſome days in a cellar, ſtirred two or three times a day, then put into a low glaſs body fitted with a head, and expoſed to a gentle heat till the matter becomes thoroughly dry; after which, the fire is increaſed till nothing more will ſublime. After the water has ariſen, a volatile ſpirit comes over, and after this a little acid ſpirit. The flowers which ſucceed, are of an orange yellow, a reddiſh and pale yellow colour, and are found to be no other than the Sal ammoniac in its whole ſubſtance, tinged by the Iron which it has volatilized. The reſiduum deliquiates in the air, and appears to be no other than a ſolution of the Iron in marine acid. It is cuſtomary to grind the flowers with the reſi- Martial flowers.

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duum, and ſublime them afreſh to repeat this operation ſeveral times, the flowers becoming by this means of a deeper and deeper red colour. I once tried how much Sal ammoniac a certain quantity of *Hæmatites* was capable of tinging: At firſt I took two pounds of each, and to the reſiduum of this proceſs added one pound of freſh Sal ammoniac, repeating the ſublimation with a pound of Sal ammoniac every time for twelve times ſucceſſively. All the fourteen pounds of Sal ammoniac were thus tinged by the two pounds of bloodſtone: Till the eleventh ſublimation the flowers ſeemed to be deeper and deeper coloured, but thoſe of the following ſublimations were paler: On mixing with the laſt reſiduum another pound of Sal ammoniac, the ſublimate had little colour; and on trying a pound more it aroſe grey. Some inſtead of filings of Iron or Bloodſtone, uſed Crocus of Iron, or *Caput mortuum* of Vitriol: The flowers in either caſe are the ſame.

Deliquefcence of Sal ammoniac and Vitriol.

It is obſervable, that green Vitriol and Sal ammoniac ground together grow ſoft as pap, and in part liquefy, eſpecially if the quantity of Vitriol is double or equal to that of the Sal ammoniac. There ſeems to happen here a tranſpoſition of the conſtituent parts of the ingredients: The acid of the Vitriol is transferred into the volatile Alcali of the Sal ammoniac; and the acid of the Sal ammoniac into the Iron of the Vitriol: Hence the taſte of the compound is extremely ſtyptic, like that of the common ſolutions of Iron in the marine acid.

Flowers of Copper; of Regulus of Antimony.

Venereal and antimonial flowers of Sal ammoniac have likewiſe been prepared for medicinal uſe, the firſt by ſubliming the Salt with *Caput mortuum* of blue Vitriol, the latter with Regulus of Antimony. The antimonial flowers are one of the more violent preparations of that mineral; and the venereal ones, like the other preparations of Copper, are entirely unſafe. The ſimple Regulus of Antimony yields white flowers; the martial Regulus fine red ones, eſpecially if the ſublimation be ſeveral times repeated till little or nothing is left.

Aqua regia.

Sal ammoniac diſſolved in four times its quantity of Spirit of Nitre, makes the common Aqua regis: The Salt ſhould be previouſly pulveriſed in a glaſs or ſtone mortar; and a gentle warmth applied to promote its ſolution in the ſpirit. If a ſpherical glaſs veſſel be nearly filled with good Spirit of Nitre, a quantity of Sal ammoniac, more than it can diſſolve, thrown in, and the whole ſuffered to remain quiet, a curious vegetation ariſes, which Kunckel was the firſt I know of that obſerved. Sal ammoniac, Quick-lime and water, kept for a night in a Copper or braſs veſſel, or along with pieces of Copper, diſſolve a part of the metal, by which the liquor is tinged blue: This is the *Aqua cærulea* or *Sapphirina* of the ſhops. The Copper is here diſſolved by the volatile Alkali of the Sal ammoniac extricated by the Quick-lime.

Volatile Salt; general principle of its ſeparation.

The volatile alcaline Salt, and the ſpirit, or ſolution of the volatile Salt, are the principal preparations of Sal ammoniac kept in the ſhops. The volatile Alcali is never to be ſeparated without the intervention of ſome other body with which the acid has a greater affinity, as fixed alcaline Salts or abſorbent earths. One part of powdered Sal ammoniac is commonly mixed with two or three of Salt of Tartar or purified Potaſh, the mixture moiſtened with a little Spirit of Wine, put into a retort, to which a receiver is adapted, and the fire increaſed

by

by degrees: In England whiting is uſed for the intermedium, and aludels are ſometimes applied to the retort. By either of theſe methods, the volatile Salt ſublimes in a concrete form, the marine acid of the Sal ammoniac remaining united with the fixt Salt, or the whiting, at the bottom of the retort. SAL AMMONIAC.

Tournefort obtained ten ounces of volatile alcaline Salt from fifteen of Sal ammoniac. Hoffman affirms that ſixteen ounces of Sal ammoniac contain twelve of Alcali and four of Acid. Geoffroy obtained no leſs than thirteen ounces from ſixteen, beſides a conſiderable quantity of ſpirit, that is of Salt diſſolved; inſomuch that he concludes fifteen ounces in the pound to be pure volatile alcaline Salt, and only one ounce acid. (See the French Memoirs for the year 1723.) He appeals to two other experiments for the truth of this aſſertion. The firſt is, the production of a Sal ammoniac perfectly neutralized, from fifteen ounces of volatile alcaline Salt and a quantity of Spirit of Salt that ſhall be found to contain an ounce of pure acid: The ſecond experiment is, that if a mixture of three parts of dry Salt of Tartar and one part of dry Sal ammoniac be ſtrongly calcined in a crucible, that all the volatile Alcali may be expelled, the acid retained by the Salt of Tartar will increaſe its weight only one ſixteenth of the weight of the Sal ammoniac employed. It ſeemed to me improbable, that a ſingle ounce of acid ſhould fully ſaturate fifteen ounces of volatile Alcali; and therefore I repeated both the ſublimation and the counter-proofs he appeals to. One pound of Sal ammoniac, and three of Salt of Tartar, thoroughly dried, and reduced into fine powder, were well mixed together, put into a retort, the junctures cloſely luted, and after ſtanding for a night ſublimed: The volatile concrete Salt amounted to no leſs than thirteen ounces: There was alſo ſome ſpirit, but not ſo much as that two ounces more of Salt could be reckoned for it; and the quantity of reſiduum was a good deal greater than Geoffroy's. I repeated the experiment with pure dry Salt of Tartar prepared on purpoſe, and with purified Potaſh: With this laſt the quantity of volatile Salt was an ounce leſs than with the other. With regard to the other experiments, an ounce of pure and pretty ſtrong Spirit of Salt required for its ſaturation two drams of volatile Alcali; and fixt Alcalies calcined with Sal ammoniac, inſtead of gaining loſt notably of their weight. Three drams of Salt of Tartar, after gentle calcination with one dram of Sal ammoniac, weighed but two drams thirty-four grains: The ſame quantities calcined by a ſtronger fire, left but one dram and two ſcruples. I likewiſe calcined ſome Salt of Tartar by itſelf, and found it to loſe ten grains upon a dram: Calcined with twice its weight of Sal ammoniac it loſt exactly the ſame. Half a dram of the calcined Salt being mixed with half a ſcruple of Sal ammoniac, there remained after calcination no more than twenty-five grains. From theſe experiments it appears, that a part of the Salt of Tartar is volatilized by the Sal ammoniac (*q*), and that the Sal ammoniac does not contain ſo much volatile Salt as

quantity.

Salt of Tartar volatilized.

(*q*) *Salt of Tartar volatilized by Sal ammoniac.*] Mr. du Hamel has fully proved that a conſiderable portion both of fixed alcaline Salts and of Chalk, is elevated in ſublimation along with the volatile Salt of Sal ammoniac: By both intermedia he obtained more, ſometimes one half more volatile Salt, than the quantity of crude Sal ammoniac made uſe of: Even the volatile Salt itſelf, by bare ſublimation from fixed Alcalies,

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as is produced in its analyſis. Probably Geoffroy's obtaining more volatile Salt proceeded from ſome differences in the fixed Salts made uſe of: The French Potaſh, and Quick-lime, are found in ſome experiments to differ from ours: Proceſſes with Quick-lime, which I have performed numbers of times at London without once failing, I could never once make ſucceed at Paris.

Spirit of Sal ammoniac.

Spirit of Sal ammoniac is no other than the volatile Salt diſſolved in phlegm or water. The moſt commodious method of preparing it is, to diſſolve the Sal ammoniac in as little water as it will diſſolve in, and to pour into this ſolution, in a retort, a ſolution of an equal quantity or more of Salt of Tartar or Potaſh, then immediately to lute on a receiver, and proceed to diſtillation with a gentle fire: The volatile Salt will ariſe before the water, and concrete about the ſides of the receiver: When water enough has come over to diſſolve the Salt, the proceſs ſhould be diſcontinued. The ſpirit will now be fully ſaturated with Salt; whereas if the diſtillation is protracted beyond this period, the ſpirit will be proportionably weakened or diluted.

Calcareous earths, as Chalk or Whiting, extricate the volatile Alcali of Sal ammoniac as effectually as fixt Alcalies; but they do not produce their effect till they have ſuffered ſome degree of calcination. If Sal ammoniac and fixt Alcali be barely mixed together either in a ſolid or a liquid form, a ſtrong pungent odour will inſtantly diſcover that the volatile Alcali is ſet at liberty; but on mixing the Sal ammoniac with Chalk no ſmell is perceived till the matter has been conſiderably heated, and then the volatile Salt ſublimes in its proper form.

Spirit with Quick-lime.

When the earth is previouſly calcined into Quick-lime, the phænomena are very different. Quick-lime mixed with Sal ammoniac, raiſes immediately a more volatile and penetrating ſmell than that occaſioned by fixed Alcalies: From this mixture no concrete Salt is obtainable, the whole of the Salt being converted into a permanently fluid ſpirit, and its ſubtility and volatility remarkably increaſed——The Spirit of Sal ammoniac with Quick-lime may be prepared from one part of the Salt, and three of the Lime broke in pieces about the ſize of hazel nuts. The Sal ammoniac is to be diſſolved in water, and put into a retort, the Quick-lime thrown in, and a receiver immediately luted on: A ſmall quantity of a very ſubtile ſpirit will ariſe during the ſlaking of the Lime: When the heat proceeding from this cauſe ceaſes, a gentle fire is to be applied, and continued till nothing more will come over. If a ſtronger ſpirit is wanted, ſlaked Lime; and if a ſtill ſtronger, freſh Quick-lime may be uſed, without any water. From eight ounces of Sal ammoniac and ſixteen of Lime ſlaked in the air, I have obtained ſix ounces and ſix drams, ſometimes more though oftener leſs: From the ſame quantities of Sal ammoniac and freſh Quick-lime I gained only one ounce and ſix drams; but this laſt ſpirit was far more

lies, in a moderate heat, gained an augmentation of its weight. The volatile Salts, thus loaded with Salt of Tartar or Chalk, did not part with their fixed matter on being diſſolved in water, and repeatedly ſublimed or diſtilled with very gentle degrees of heat: They totally ſublimed alſo when neutralized by acids into ammoniacal Salts: A ſolution of them in water, expoſed for ſix weeks to the air, and then exhaled, left nothing behind. But on expoſing one of them dry to the air, there remained a fixed ſubſtance, which proved to be Chalk.

more volatile than the other, and so strong as to strike one down upon incautiously taking off the receiver: The spirit with slaked Lime, though far stronger than the common Spirit of Sal ammoniac, was mild in comparison to this. SAL AMMONIAC.

The Spirit of Sal ammoniac made with fixed alcaline Salts, effervesces strongly with all acids; the spirit made with Quick-lime very weakly. Hoffman affirms, that the spirit prepared with Quick-lime raises no effervescence with any acid, misled by confounding the aqueous or pure spirit with the vinous. Both the aqueous and vinous spirits made with fixed alcaline Salts effervesce strongly: The vinous with Quick-lime, not at all; the aqueous with Quick-lime very sensibly, though not near so much when newly distilled as after it has been long kept: On keeping for ten years it lost almost all its volatility and subtility, and in this state it effervesced strongly—Homberg reports that Spirit of Sal ammoniac raises no effervescence with any vegetable acid; but the spirit with fixed Alcalies manifestly does, if added in due proportion, and even that with Quick-lime produces a sparkling. The common vegetable acids are so dilute, that when they are added to alcaline liquors, a large quantity of the acid must be poured in to raise any sensible commotion: To a dram of good Spirit of Sal ammoniac I have often added a pound, a pound and a half, and even two pounds of weak distilled Vinegar, before the effervescence begun. On the other hand, if we drop the volatile spirit into strong distilled Vinegar an effervescence will soon appear. Effervescence of the volatile spirits with acids.

The singular effects of Quick-lime in the distillation of Sal ammoniac have been accounted for by many, but on principles groundless or absurd: Their true cause may, perhaps be, that the Quick-lime absorbs and detains the earthy matter which is the basis of the volatile Salt, and on which its solid form and its effervescence with acids depend. I have tried the effect of Quick-lime in composition with fixed Alcalies, and found that four drams of Sal ammoniac and eight of Salt of Tartar, with one dram of Quick-lime moistened with a little water, yielded both a concrete Salt and a Spirit; that with two drams of Quick-lime a dry Salt was still obtained; but that upon increasing the Quick-lime to three drams and a half, only a fluid volatile spirit arose. I have likewise treated with Quick-lime the Salt and Spirit prepared by fixed Alcalies: A little Quick-lime added to the Spirit, diminishes its volatility more and more in proportion to the quantity of Lime: Twelve ounces of a saturated Spirit being drawn over twenty times from fresh parcels of Quick-lime, three ounces each time, the volatility of the spirit was in good measure destroyed, and by a few more repetitions it was totally so: The concrete volatile Salt I have totally destroyed by bare Lime-water. [See page 16.] Divers experiments with Quick-lime.

The volatile Alcali of Sal ammoniac is extricated also in a fluid state by some metallic substances. One part of Sal ammoniac ground with three of Minium, and distilled in a retort, yields a small quantity of alcaline Spirit, the most penetrating and caustic of any volatile Alcalies I know of: A single drop laid on the tongue, quickly makes a hole as large as half a pea. The residuum of this process has oftentimes an elegant Marble-like appearance. Some disputes with the elder Geoffroy, who in defence of his table of affinity, attributed the extricating of the Alcali of the Sal ammoniac to a fixed alcaline or calcareous matter produced in the Minium during its preparation, induced me to exa- Caustic volatile Spirit, by metallic substances.

SAL AMMONIAC. mine ſome other metallic bodies in their metallic ſtate, where no ſuch cauſe can be ſuppoſed to exiſt: Filings of Lead, Zinc, Regulus of Antimony, Iron, were all found to extricate a little volatile ſpirit.

Volatile with vinous ſpirits. Spirit of Sal ammoniac made with fixed Alcalies, forms on the admixture of rectified Spirit of Wine, a white coagulum, called *Offa alba*, the volatile Salt not being ſoluble in the vinous ſpirit, and being diſlodged by it from the water which held it in ſolution before. The ſpirit made with Quick-lime, on the other hand, whoſe ſaline matter is ſo attenuated as not to aſſume a ſolid form, unites equably with the moſt highly rectified Spirit of Wine, without coagulation or precipitation. Hence this laſt ſpirit is much better adapted than the other for mixtures with vinous ſpirits——The vinous or dulcified Spirit of Sal ammoniac of the ſhops is prepared with fixed alcaline Salts, and conſequently holds but little of the volatile Alcali: Some mix the aqueous alcaline Spirit with Spirit of Wine, and others uſe a vinous ſpirit inſtead of water, in the firſt diſtillation.

It may ſeem a paradox, that volatile Alcalies ſhould precipitate a fixed Alcali, and that they ſhould precipitate it from a liquor with which they ſeem to have themſelves ſo little affinity as Spirit of Wine. Such however is the caſe: Stahl's *Mixtura Tonico-nervina* conſiſts of the *Tinctura Tartari* or *Tinctura Antimonii* and volatile ſpirit; when a large quantity of the fixed alcaline tincture is added to a ſmall one of the volatile ſpirit, an *Oleum Tartari per deliquium* ſeparates to the bottom.

Volatile oily ſpirits. Sundry compound or oily Spirits of Sal ammoniac are kept in the ſhops for medicinal uſes. There are various compoſitions of theſe kinds of liquors, and various methods of preparing them. Different aromatic and other ſubſtances, as Aniſeeds, Fennel-ſeeds, Lavender, Juniper-berries, Cloves, Saſſafras, Amber, *&c.* or the oils diſtilled from them, ſingly or combined with one another, are digeſted in the vinous Spirit of Sal ammoniac, or diſtilled along with it, or added in its firſt diſtillation from Sal ammoniac and fixt alcaline Salt. The diſtillation of theſe kinds of compoſitions is entirely unneceſſary, nor is it at all needful to keep them ready prepared in the ſhops, as they may be eaſily made extemporaneouſly with different oils, or different proportions of oil, as the phyſician may think fit. It is ſufficient if we have at hand a good dulcified Spirit of Sal ammoniac that will readily diſſolve oils.

Uſes of volatile Alcalies. The Salt and Spirit of Sal ammoniac are the pureſt of the volatile Alcalies, and hence generally made choice of for chemical operations, as the precipitation of Aurum fulminans, of Mercury, *&c.* It is obſervable, that theſe ſpirits precipitate Mercury from Aqua fortis of a blackiſh-grey colour, but from ſolution of corroſive Sublimate white, and that they give a blackiſh colour to *Mercurius dulcis.* Medicinally, they are exhibited as ſtimulants, aperients, *&c.* in paralytic, hyſteric, and ſundry other diſorders: In plethoric habits they ſhould be given with caution, as they are apt in theſe caſes to bring on dangerous hæmorrhages. The volatile Salt was formerly given by a dram at a time, but the preſent practice has juſtly reduced the doſe within ſmaller limits. Boerhaave obſerves that this Salt is ſo corroſive, that when laid upon the moiſt ſkin, and covered with a ſticking plaſter to prevent its flying off, it preſently occaſions a violent inflammation and gangrene. The Salt either by itſelf,

itſelf, or impregnated with odoriferous oils, is uſed in ſmelling bottles by the name of Engliſh Salts. The ſpirit made with Quick-lime is ſeldom given internally on account of its great pungency, but frequently uſed for ſmelling to, and in ſome external applications: Agitated with oils, it readily unites with them into the conſiſtence of a liniment. SAL AMMONIAC.

What remains in the retort after the diſtillation of the volatile Salt and Spirit of Sal ammoniac, is the marine acid of that concrete combined with the intermedium. When fixed alcaline Salts have been uſed, the reſiduum diſſolved in water and cryſtallized, proves no other than a regenerated Sea-ſalt, though dignified with the titles of *Sal digeſtivum*, *aperitivum*, *febrifugum*, *diureticum*, *hypochondriacum*, *embryonatum*. Where Quick-lime has been employed, the reſiduum elixated with water, yields on evaporating the ſolution, a pungent ſaline maſs, called *Sal ammoniacum fixum*, ſimilar to one prepared by diſſolving Lime directly in the marine acid. Reſidua after the diſtillations.

Hitherto we have ſeen the volatile Alcali of Sal ammoniac extricated in its proper form, by the addition of ſubſtances which abſorb the acid: We may likewiſe obtain the acid in its pure ſtate, by additions which abſorb the Alcali; for without additions of one or the other kind, no ſeparation can be made. If Oil of Vitriol be dropt upon Sal ammoniac in a tubulated retort, a highly concentrated marine acid ariſes in white clouds, which difficultly condenſe, and in part eſcape through the luting, unleſs ſome liquid is placed in the receiver to imbibe them and promote their condenſation: This ſpirit is in all reſpects the ſame with that obtained by the ſame means from common Salt: The reſiduum is the ſame with the combination of vitriolic acid and volatile Alcali called *Sal ammoniacum ſecretum*. See page 194. Acid ſpirit of Sal ammoniac.

Three parts of Sal ammoniac and two of Nitre, mixed together, and injected into a tubulated retort made red-hot, yield a compound acid ſpirit, participating of the marine acid of the one ingredient, and the nitrous of the other. This proves a ſubtile kind of Aqua regis: It is called by Baſil Valentine and others, *Aqua pugilum*, and *Aqua chryſulca*. In ſome places, common Aqua regis is called *Aqua chryſulca*. This laſt name gave once occaſion to a fatal miſtake: A Poliſh gentleman having aſked for Brandy by the Poliſh name *Gorzalko*, received the *Aqua chryſulca*, and was killed by it. Aqua pugilum.

ARTICLE III.

Combination of the marine acid with earths.

THE marine acid diſſolves all the mineral calcareous earths, and the aſhes of vegetable and animal ſubſtances, but not all with equal facility or in equal quantity. An ounce of Spirit of Salt diſſolved but forty-ſix grains of Bezoar-ſtone: Of Pearl and Mother-of-pearl it took up two drams; of ſea-ſhells, Coral, and calcined Hartſhorn ſomewhat more; of Quick-lime, and of ſlaked Lime, ſtill more; of Crab's eyes, three drams and upwards: Theſe laſt it diſſolves not only in largeſt quantity, but moſt readily of all the earths made trial of. The ſolutions of ſome of the earths, as eggſhells, are in taſte remarkably bitter. Marine acid with different earths.

SAL AMMONIAC. Fixed Sal ammoniac.

All the combinations of the marine acid with earthy bodies, when exſiccated by heat, liquefy again in the air; hence they have been often miſtaken for a fixt alcaline Salt, particularly the combination with Quick-lime, which being obtained as a ſecondary product in the diſtillation of Spirit of Sal ammoniac with that earth, has been in general more known than the others, and diſtinguiſhed by the name of *Sal ammoniacum fixum*. This Salt melts in a ſmall heat, like water, and being poured into a clean Iron mortar, appears when cold, of a yellowiſh white colour, and ſemitranſparent like horn. Fixed alcalies added to a diluted ſolution of it, precipitate the earth, and form with the acid a regenerated Sea-ſalt: If the ſolutions of the fixed Sal ammoniac and of the Alcali are both ſaturated, inſtead of a precipitation, the two liquors coagulate on mixture and become conſiſtent. Homberg obſerves, that fixed Sal ammoniac melted into a maſs, appears luminous in the dark on being beat in a mortar or ſtruck upon with a hammer, and hence calls it a new Phoſphorus: The experiment does not always ſucceed.

Phoſphorus.

BORAX.

BORAX. Hiſtory.

BORAX is a ſaline ſubſtance, of which neither the origin, or the component parts are as yet known. It comes from the Eaſt-Indies in little cryſtalline maſſes, ſomewhat reſembling ſmall cryſtals of Sal gem, mixed with earth and other impurities. Whether it is a natural or artificial production, we have no ſatisfactory account: Moſt probably it is in great meaſure artificial, and the earthy matter deſignedly mixed with it, to make us look upon it as a foſſil Salt peculiar to the Indies. It is refined in Europe, but this proceſs alſo is kept a ſecret: Some additional ſubſtances are generally ſuppoſed to be employed, the refined Borax being in larger cryſtals than we can make this Salt to ſhoot into by itſelf (*r*). The refining of Borax was formerly practiſed only

(*r*) *Hiſtory of Borax.*] It is commonly ſaid, that Borax is prepared in the eaſtern countries from a green ſaline liquor, which runs from certain hills, and is received in pits lined with clay, and ſuffered to evaporate by the ſun's heat; that a bluiſh mud, which the liquor brings along with it, is frequently ſtirred up, and a bituminous matter which floats upon the ſurface taken off; that when the whole is reduced to a thick conſiſtence, ſome melted fat is mixed, the matter covered with dry vegetable ſubſtances, and a thin coat of clay: And that when the Salt has cryſtallized, it is ſeparated from the earth by a ſieve.

In the ſame countries is found in conſiderable quantities, a native mineral alcaline Salt on the ſurface of the earth, ſometimes tolerably pure, more commonly blended with heterogeneous matters of various colours; the *Nitrum* or *Natron* of the ancients, the *Baurach* of the Arabians. This Alcali appears to be the ſame with the baſis of Sea-ſalt, and with the lixivial Salt of Kali or Kelp and ſome other maritime plants. It differs from the common vegetable Alcalies, in being milder and leſs acrid in taſte, aſſuming a cryſtalline appearance, not deliquiating in the air, or very ſlowly; forming with the marine acid a perfect Sea-ſalt, with the nitrous quadrangular Nitre, and with the vitriolic a Sal mirabile.

Mr. Pott received from Tranquebar, (where the greateſt quantities of Borax are made) a ſand, under the name of Ore of Borax, with an account that certain acrid vegetable

only at Venice, and hence the refined Borax was called Venetian; but the Dutch are now the only maſters of this manufacture. Serapio calls the rough Borax as it comes from the Indies, *Tincar*; and the dealers in this commodity ſtill diſtinguiſh it by the name *Tincar* or *Tincal*, never calling it Borax till it is refined. *Baurach* among the Arabians, and *Chryſocolla* among the Greeks, were names for this Salt, but they were applied alſo to other ſubſtances; the firſt to the *Natrum* or Nitre of the ancients: the latter to a green cupreous mineral now called *Berggrun* or *Viride montanum*.

There are great numbers of proceſſes in books for making Borax by art: I have tried thoſe which ſeemed to be the beſt, and made ſundry other experiments on principles of my own, without being ever able to ſucceed. That this Salt is nevertheleſs artificially producible, I make no queſtion: Stahl obtained cryſtals

Proceſſes for artificial Borax, falſe.

getable matters were added in the preparation of the Borax. The ore yielded on elixation, only the mineral Alcali, with a little Sea-ſalt.

The mineral Alcali appears from experiment to be a principal ingredient in Borax. On treating Borax with acids, about one fourth its weight of a peculiar ſaline ſubſtance (called ſedative Salt) is ſeparated, and the reſiduum proves a combination of the Alcali with the acid employed: Thus when the marine acid is uſed a genuine Sea-ſalt remains; when the nitrous, a quadrangular Nitre; and when the vitriolic, a Sal mirabile. The ſubſtance ſeparated joined to the mineral Alcali, to the baſis of Sea-ſalt, or to the Salt of Kali, recompoſes Borax again.

The properties of this ſubſtance, ſo far as they are known, are theſe. It is of a bright ſnowy whiteneſs, extremely light, compoſed of fine plates or ſcales, ſoft, and as it were unctuous to the touch, of no ſmell, of a bitteriſh taſte, accompanied with a ſlight impreſſion of coldneſs. It diſſolves difficultly in boiling water, and on the liquor's cooling, cryſtallizes on its ſurface, into thin plates; which uniting and becoming larger, fall to the bottom. It likewiſe diſſolves, by the aſſiſtance of heat, in rectified Spirit of Wine: The ſolution ſet on fire burns with a green flame. Moiſtened and expoſed to a conſiderable heat, it in part ſublimes; by repeated humectations the whole may be elevated. Whilſt dry, it proves perfectly fixed: It melts, emits aqueous vapours, and runs into a vitreous ſubſtance, diſſoluble again as at firſt: Neither the glaſs nor the Salt itſelf are affected by the air. It makes no change in the colour of blue flowers. It unites with the common alcaline Salts, in ſome degree neutralizes, and renders them capable of cryſtallization. It is ſaid to expel from Alcalies every acid except the vitriolic, though expelled itſelf by every acid from the alcaline baſis of the Borax.

Thus we find Borax compoſed of two principles, one every where plentiful, another which has not hitherto been obtained but from Borax itſelf; the laſt in the ſmalleſt proportion. How far this peculiar ſubſtance is natural or artificial, of mineral or of vegetable origin, is wholly unknown.

With regard to the refining of Borax, the rough Salt is ſaid by ſome to be diſſolved in Lime-water, by others in alcaline Lixivia, by others in a Lixivium of cauſtic Alcali, and by others in Alum-water. Thus much is certain, that Borax diſſolved in common water, and cryſtallized in the common manner, forms extremely ſmall cryſtals: That theſe differ in ſeveral reſpects from the refined Borax of the ſhops, inſomuch that Cramer calls the latter not a purified but adulterated Borax; that Borax ſhoots into larger cryſtals when diſſolved in Lime-water than in common water; and when the veſſel is covered, and a gentle warmth continued during the cryſtallization, than in other circumſtances... It is obſervable that Borax, during its diſſolution appears tenacious, and adheres in part to the bottom of the veſſel: From this glutinous quality, peculiar to Borax among the Salts, it is employed by the dyers for giving a gloſs to ſilks.

BORAX. cryſtals approaching to Borax from certain antimonial ſcoriæ expoſed for a length of time to the air. See his ſupplement to Becher's *Phyſica Subterranea*.

General properties. Refined Borax is a ſolid, colourleſs, tranſparent, cryſtalline Salt, apparently of the neutral kind, but inclining to an alcaline nature. It makes no effervescence with alcalies or acids. It has ſomewhat of an alcaline taſte, changes Syrup of Violets greeniſh, extricates a little volatile Alcali from Sal ammoniac, throws down an orange-yellow Precipitate from ſolution of Sublimate corroſive, and precipitates ſundry metallic and earthy ſolutions made in acids, as ſolution of green, blue, and white Vitriol, of Mercury in Aqua fortis, of Silver in Aqua fortis, of Copper in Spirit of Salt, of Lead in Vinegar, of Copper in Vinegar, of Zinc, of Biſmuth, of Iron in Aqua regis and in Spirit of Nitre, of Alum and of fixed Sal ammoniac. It precipitates alſo ſome ſolutions made in Alcalies, as Sulphur diſſolved in alcaline Lixivia, and Reſin diſſolved in a ſolution of fixed Nitre. It precipitates Sulphur from Lime-water: On mixing a ſolution of Borax with Lime-water itſelf, a turbidneſs and precipitation enſue: Spirit of Sal ammoniac made with Quick-lime produces a like effect after the mixture has ſtood for ſome days (*s*).

Precipitates ſundry acid and alcaline ſolutions.

Examined by water. This Salt requires thirty times its own weight or more of water to diſſolve in. The cryſtals expoſed to the ſun, loſe a part of the humidity of which they contain a large quantity in their cryſtalline form, and fall by degrees into a white powder.

In the fire. In the fire they readily melt and boil up, and parting with their water, turn to a light, white, ſpongy maſs, which on raiſing the heat melts into a ſubſtance like Glaſs (*t*). Lemery relates that this Glaſs will ſtill diſſolve in water,

(*s*) *Borax with acids*, &c.] All acids diſſolve Borax ſlowly and without effervescence. It precipitates from them moſt, but not all metallic ſubſtances; along with which a conſiderable part of the Borax is generally depoſited. It does not abſorb the marine acid of *Luna cornea* or of Mercury-ſublimate: It flows upon the ſurface of the firſt without uniting, and ſuffers the latter to ariſe unchanged: The Borax in both caſes becomes coloured, in the firſt milky with red ſtreaks, in the latter amethyſt or purple. Mixed with Sal ammoniac, it extricates the volatile Alcali and retains the acid; but mixed with the combination of the ſame acid with calcareous earths, called fixed Sal ammoniac, it extricates the acid, and unites with the earth. It extricates the acid of Nitre, without ſeeming to unite with the alcaline baſis of that Salt. Nor does it mingle in fuſion with the common fixed alcaline Salts, the Borax flowing diſtinct upon the ſurface—— A mixture of Borax with twice its weight of Tartar, diſſolves in one ſixth the quantity of water that would be neceſſary to diſſolve them ſeparately: The liquor yields on inſpiſſation, a viſcous tenacious maſs like glue, which refuſes to cryſtallize, and which deliquiates in the air. Borax affords likewiſe a glutinous compound with the other acids, except the vitriolic: It proves moſt glutinous with the vegetable, and leaſt with the marine——With oils both expreſſed and diſtilled, it forms a milky ſemiſaponaceous compound. It partially diſſolves in Spirit of Wine. In conjunction with any acid, it tinges the flame of burning matters green: The Precipitate thrown down by it from metallic ſolutions has this effect—It does not deflagrate with Nitre. Fuſed with inflammable matters, it yields nothing ſulphureous as thoſe Salts do which contain vitriolic acid.

(*t*) *Glaſs of Borax.*] Borax is the only Salt that aſſumes a vitreous appearance from fire without addition. The Glaſs ſo called, becomes opake and at length powdery in the air, like the Borax at firſt, the Salt ſeeming to have ſuffered from this proceſs no other real alteration than the loſs of about half.

water, and cryſtallize into Borax again. If the fuſion is performed in a retort with its receiver, we obtain from a pound of Borax near ſeven ounces of phlegm; the vitrified reſiduum weighs a little more than nine ounces. The phlegm has ſomewhat of a ſoapy ſmell: If Salt of Tartar be added in the diſtillation, the diſtilled liquor proves manifeſtly unctuous or oily. Lemery obtained from an ounce and a half of Borax and twice as much dry Clay, three drams of an urinous liquor. BORAX.

Borax is uſed chiefly in ſoldering, for promoting the fuſion of calces of Gold and Silver, and reuniting the particles of thoſe metals into one maſs when diffuſed through a quantity of earthy matter, for facilitating the vitrification of calces of Antimony, &c. It weakens the colour of Gold, and by repeated fuſions renders it quite pale (*u*). It is ſometimes employed medicinally in compoſitions for promoting delivery as an emmenagogue in aphrodiſiac, coſmetic, dentifrice, &c. Uſes.

The principal preparation of Borax is a volatile ſaline concrete, called *Flores boracis*, *Sal volatile vitrioli*, *Flores vitrioli philoſophici*, *Sal volatile narcoticum*, and by ſome *Sal album alchymiſtarum*. This is made ſometimes with the *Caput mortuum* of Vitriol, and ſometimes with Oil of Vitriol——Three pounds of the *Caput mortuum* or Colcothar of green Vitriol, are elixated with ſix or ſeven quarts of boiling water, and the filtered liquor mixed with a ſolution of two ounces of Borax in a quart of boiling water. The mixture ſuffered to ſettle for twelve hours, and poured off clear from the ſediment, is evaporated to two pounds or a quart, then put into a glaſs body, and treated with a gradual fire: A fine ſparkling Sublimate ariſes, which, after the veſſels have grown cold, is to be ſwept out with a feather. If the phlegm which comes over be returned on the reſiduum, a little more Sublimate may be obtained, and this repeatedly for a ſecond and a third time——The method of preparing the Salt with Oil of Vitriol is, to diſſolve two ounces of Borax in a quart of water, gradually drop into the ſolution one ounce of Oil of Vitriol, evaporate about one third of the mixture, and then diſtil and cohobate as before——This Salt was firſt diſcovered by Mr. Homberg, and is uſed by the French phyſicians in fevers and ebullitions of the blood, in deliria, convulſions, hypochondriacal and hyſterical Sedative Salt.

half its weight of phlegm. It continues a perfect Salt, and is by no means changed, as Stahl ſuppoſes, to an earth.

Borax rendered fluid by fire, diſſolves moſt kinds of earthy bodies and metallic calces, more readily and more perfectly than alcaline or other Salts: The moſt compact crucibles do not long ſuſtain its action. Nevertheleſs a ſlight glazing with Borax is ſaid to defend the veſſel for ſome time from being corroded by glaſs of Lead, as well as by filling its pores to prevent the abſorption of any particles of metals melted in it.

The glaſſes which Borax forms with earths are in general very hard and compact, and when newly prepared, of great brightneſs and tranſparency. On long expoſure to the air, they are apt, like Borax itſelf, to become cloudy; and if its proportion is very large, opake.

(*u*) *Makes Gold pale.*] This effect is prevented by the addition of Nitre or Sal ammoniac, or the colour of the Gold reſtored, by remelting it with either of thoſe Salts—I have obſerved likewiſe, that it renders Braſs and Princes-metal pale, the Borax acquiring a deep reddiſh hue; that it gains a like colour on being melted with Copper, and a darker blackiſh from Iron.

BORAX. rical affections. Its particular nature is as yet unknown: It has no volatile ſmell, or pungent taſte, and appears to be of the neutral kind.

I have prepared this Salt by a more commodious method than that of Homberg, without ſublimation or diſtillation. A ſolution of Borax being mixed to ſaturation with a ſolution of Alum, the earth of the Alum precipitates: The remaining liquor evaporated to a certain pitch and ſet to ſhoot, yields firſt fine cryſtals, the ſame with the ſublimed flowers. If the proceſs be continued, the cryſtals which ſhoot afterwards are found to be of a different kind——A further account of Borax, and enquiries into its nature and properties, may be ſeen in Pott's *Obſervationes & animadverſiones chemicæ, collect.* ii. and Modell's diſſertation *de Borace nativa à Perſis* borech *dicta*.

SECT. IV.

BITUMINOUS SUBSTANCES.

BITUMENS. BITUMENS are inflammable mineral bodies, not ſulphureous, or only caſually impregnated with Sulphur. They are of various degrees of conſiſtency, and ſeem in ſome meaſure to correſpond in the mineral kingdom, to the oils and reſins of the vegetable. There is a perfectly fluid, Naphtha. thin Bitumen, or mineral Oil, called *Naphtha*, clear and colourleſs as Cryſtal, of a ſtrong ſmell, extremely ſubtile, ſo light as to ſwim on all known liquors, ſpreading to a vaſt ſurface on water and exhibiting rainbow colours, highly inflammable, formerly made uſe of in the compoſition of the ſuppoſed inextin- Petroleum. guiſhable Greek fire. Next to this in conſiſtence is the *Oleum petræ* or *Petroleum*; which is groſſer and thicker than *Naphtha*, and of a yellowiſh, reddiſh or browniſh colour, but very light, ſo as to ſwim even on Spirit of Wine. By diſtillation, the Petroleum becomes thinner and more ſubtile, a groſs matter being left behind: It does not eaſily ariſe, nor does it totally loſe its colour by this proceſs, without particular managements or additions.

Their natural hiſtory. Both Naphtha and Petroleum are found plentifully in ſome parts of Perſia, trickling through rocks, or ſwimming on the ſurface of waters. Kæmpfer gives an account of two ſprings near Baku, one affording Naphtha, which it receives in drops from ſubterraneous veins, the other, a blackiſh and more fetid Petroleum, which comes from mount Caucaſus; the Naphtha is collected for making varniſhes; the Petroleum is received in pits, and ſent to Sjamachia, Baku, Media, Hyrcania, Uſbeck, Circaſſia, and Dageſtan, for lamps and torches: From this place alone are ſaid to be exported daily eight or ten thouſand batmans, each batman amounting to about nine Dutch pounds. A further account of the bituminous tracts in that part of the world, and of a burning land, *&c.* may be ſeen in the author above-mentioned, and in the

Breſlau

Breſlau collections. Native Petrolea are found likewiſe in Italy, particularly in Lombardy and the Modeneſe; and an inferior ſort, of a ſtrong diſagreeable ſmell, and ſharp bitter taſte, at Gabian in Languedoc: Alſace, Neuchatel, and ſeveral other places in Europe afford alſo Petrolea. Some years ago, a bituminous earth and Petroleum were diſcovered in the Electorate of Hanover. In the ſhops we meet with no genuine Petrolea; what is ſold under the name both of white and red Petroleum, being an artificial compoſition, conſiſting chiefly of the oil of the pine-tree, drawn over perhaps from bricks after the ſame manner as the *Oleum philoſophorum*, or diſtilled in an open fire without addition. The Dutch ſell us an *Oleum terræ*, as it is called, of a ſtrong ſmell, and tranſparent reddiſh brown colour, brought in large earthen jars from the Eaſt Indies, and ſaid to be uſed there in palſies: even this however does not ſeem to be a native Bitumen, any more than the officinal *Oleum petræ*. The officinal ſort, diſtilled from bricks, greatly reſembles it. The true Naphtha is recommended againſt diſorders of the nerves, old pains, cramps and contractions of the limbs, for diſcuſſing tumours, *&c.* BITUMENS.

There are Bitumens of a middle conſiſtence betwixt fluid and ſolid; as that called in England Barbadoes Tar, ſaid to drop from certain rocks in America. A thick adheſive Bitumen of this kind is plentiful in Auvergne in France, and proves rather incommodious than uſeful: it exudes on the ſurface of the earth, ſticks to the feet like pitch, and is there called Devil's dung. Such alſo is the *Bitumen judaicum*, which is found on the ſurface of the dead ſea, and ſaid to be raked off by the neighbouring inhabitants before it has been hardened by the ſun. Thick Bitumens.

There are ſundry Bitumens perfectly dry and ſolid, as Amber, Ambergris, Pit coal, Jet. In the Pruſſian Pomerania we have a bituminous earth, which proves an excellent fuel, eaſily taking fire, burning long, yielding no unpleaſant or prejudicial but rather an agreeable ſmell ſomewhat like that of Amber, and leaving only a ſmall quantity of perfectly white aſhes. Turf and Peat belong alſo to this claſs, as being chiefly a bituminous earth, and yielding, when firſt ſet on fire, a diſagreeable bituminous ſmell; though originally compoſed in great part of the roots of vegetables (*x*). The learned Dr. Degner Solid Bitumens.

(*x*) *Peat.*] There are very conſiderable differences in Peat, proceeding perhaps wholly from different mineral admixtures, for the ſubſtance of the Peat is plainly of vegetable origin, whence it is found to anſwer for the ſmelting of ores, and the reduction of metallic calces nearly in the ſame manner as the coals of wood. Some ſorts yield in burning a very diſagreeable ſmell, which extends to a great diſtance; whilſt others are inoffenſive. Some burn into grey or white, and others into red ferrugineous aſhes. The aſhes yield, on elixation, a ſmall quantity of alcaline ſalt, with ſometimes one and ſometimes another ſalt of the neutral kind.

The ſmoke of Peat does not preſerve or harden fleſh like that of wood; and the ſoot, into which it condenſes, is more diſpoſed to liquefy in moiſt weather. On diſtilling Peat in cloſe veſſels, there ariſes a clear inſipid phlegm, an acid liquor which is ſucceeded by an alcaline one, and a dark coloured oil. The oil has a very pungent taſte; and an empyreumatic ſmell, leſs fetid than that of animal ſubſtances, more ſo than that of the mineral bitumens: it congeals in the cold into a pitchy maſs, which liquefies in a ſmall heat: it readily catches fire from a candle, but burns leſs vehemently than other oils, and immediately goes out upon removing the external flame: it diſſolves almoſt totally in rectified ſpirit of wine into a dark browniſh red liquor.

BITUMENS. ner of Nimmägen has written an expreſs treatiſe on this ſubject, to which I refer. Sea-water and certain ſprings are likewiſe impregnated with bituminous matter, as we ſhall ſee hereafter in treating of water.

I. AMBER.

AMBER. AMBER *Succinum*, called by the Greeks *Electrum*, and by the Arabians *Carabe* from its power of attracting ſtraw and other light bodies when rubbed, is a ſolid Mineral Bitumen; not as ſome have ſuppoſed, a vegetable reſin, or inſpiſſated juice, introduced into cavities in the earth, and there indurated and ſomewhat changed in its quality; nor a true marine production, though ſometimes found in the ſea.

Its natural hiſtory. It is met with plentifully in regular mines in ſome parts of Pruſſia: the upper ſurface is compoſed of ſand, under which is a ſtratum of loam, and under this a bed of wood, partly entire, but chiefly mouldered or changed into a bituminous ſubſtance: under the wood is a ſtratum of vitriolic or rather aluminous mineral, and under this another bed of ſand, in which the amber is found. Strong ſulphureous exhalations are often perceived in the pits. Helving relates, that wherever there is Amber, there is always a bituminous earth and foſſil wood, a gravelly matter, Vitriol, Nitre, and Sulphur; and that the matter of the Amber reſides in the foſſil wood. The obſervation appears to be juſt, except in regard to Nitre, which is never found in the Amber pits; ſome aluminous matter was doubtleſs miſtaken for Nitre. Conſiderable quantities are met with alſo in the ſea near the Amber ſhores, particularly after a ſtorm; the ſea having probably waſhed out the mineral from the earth.

The principal Amber pits are in the territory called Sandlande, between Pillau and Fiſchhauſen, near the villages Groſshubenick, Groſsdirſchken, Warnicken, Strobſchner, Rittener, Palmnick, *&c.* The ſhores on which Amber is chiefly fiſhed for are thoſe called Krecke, Nodens, Laſſnick, Knick, Krapellen, Krackſtepellen, Crimichen, and Thieſkim or Bruſterort. The manner of fiſhing for it is pretty well deſcribed in Hartmann's *Hiſtoria Succini Pruſſici*. The digging of Amber is a very dangerous work; the ground not being ſtony or rocky as in metallic mines, but ſandy or loamy, and hence very ſubject to fall in when hollowed underneath. His Pruſſian Majeſty receives a large annual revenue from this commodity; he has a peculiar council called the Amber-chamber; and no one but thoſe appointed for that purpoſe is permitted to dig or fiſh for Amber in his dominions—Small quantities of Amber are met with alſo in ſundry other places; in Bohemia, Sileſia, Saxony, Hungary, France, *&c.* The pieces of Amber now and then found in theſe places were not, perhaps, originally produced, but left there by the flood.

Subſtances incloſed in it. Various kinds of ſubſtances are often incloſed in maſſes of Amber; as drops of water, which fall to this ſide and that upon moving the maſs; ſmall bits of wood, moſs, leaves of plants, *&c.* a variety of inſects, particularly gnats, flies, ſpiders, ants, moths, butterflies, graſshoppers, bees, worms, cantharides, caterpillars, crickets, maggots, lice, and fleas. There are reports alſo of frogs, vipers, fiſhes and other large animals being found in maſſes of Amber, and ſuch are figured in Mercatus's *Metallotheca*; but moſt of theſe are artificial

preparations: even the fiſh in Amber, in his Pruſſian Majeſty's repoſitory, is manifeſtly factitious. In my own poſſeſſion there are two hundred ſpecimens of Amber, every one of which has ſomething incloſed. It is evident from hence, that this Bitumen has once been in a fluid ſtate; though we cannot conclude that it ever was a liquid or oily matter, and acquired its conſiſtency and ſolidity by degrees. Appearances are rather contrary to this ſuppoſition. The inſects found in Amber have nothing of thoſe ſtrained or diſtorted poſtures which animals are naturally thrown into upon endeavouring to diſengage themſelves when entangled in a viſcous liquid. We often ſee pieces of Amber in which there are perfect flies with the wings and feet beautifully expanded as if they were ſtill flying. It is moſt probable, that the Amber was generated inſtantaneouſly from the concourſe of mineral oil or petroleum with vitriolic acid, in the form of vapours; which at once concreted together, and embalmed the inſects that happened to lye in their way, with a more durable and precious covering than has ever fallen to the lot of the moſt magnificent monarchs.——A bituminous wood is to be conſtantly met with in the Pruſſian Amber pits: This however, does not appear at all neceſſary to the formation of Amber. Amber is found in Italy; where there is no foſſil wood, but plenty of mineral oil or petroleum.

AMBER.

Produced from Petroleum and vitriolic acid.

There are different ſorts of Amber in regard to external appearance; opake and tranſparent; white or whitiſh, yelloviſh or yellow, greeniſh, browniſh, bluiſh, reddiſh, or browniſh red: what is called black Amber is no true Amber, but a bitumen of the Pit-coal, aſphaltum or jet kind. Some divide Amber into native and factitious: I have ſeen artificial maſſes indeed reſembling Amber in appearance; but no true Amber has hitherto been produced by art. In Holland a vegetable reſin, whoſe proper name is *Gummi de Loock*, is ſold under the name of American Amber: this, when in conſiderable maſſes, and by itſelf, is eaſily diſtinguiſhed from the genuine Amber, by its having leſs electricity, wanting the peculiar ſtrong ſmell which Amber emits in burning, by its greater ſolubility in ſpirit of wine, and not yielding the ſame principles as Amber in diſtillation: Small pieces of the reſin mixed among true Amber are more difficultly diſcovered, and this abuſe is not unfrequently practiſed.

Different forts.

Sophiſticated with a vegetable reſin.

Amber is divided by the workmen into different ſortments according to the ſize of the maſſes; the ſmalleſt and coarſeſt bits are called *Sandſtein*, the ſomewhat larger, *Schlug*; thoſe which are ſtill larger, *Firniſs*, or Varniſh Amber; the pieces which are large enough to be turned into beads, or other ornaments or utenſils, are named from the works for which they are judged to be fit. There are other diviſions taken from the quality of the maſſes. Of the opake Ambers, the moſt valuable is the flaky or ſcaly; next to this, the undulated or waved; and next in order the cloudy, the cauliflower or pearl like, the milky, the citron yellow, the wax-coloured, the dark yellow, the browniſh, and the dark brown, which laſt is the coarſeſt of all. The tranſparent Ambers are divided into reddiſh, gold yellow like a yellow glaſs, citron yellow, pale yellow, and whitiſh. Of all theſe there are ſeveral ſubdiviſions, commixtures, or intermediate ſhades; and ſometimes we meet with pieces of other colours, as greeniſh, bluiſh, coffee coloured, opal coloured, &c.

Natural differences.

AMBER. With regard to the tranſparent Ambers, it may be proper to take notice; 1. That inſects or other foreign bodies are obſerved chiefly in theſe; poſſibly they may often be lodged alſo in opake Amber, though the opacity of the maſs prevents our ſeeing them. 2. That opake Amber is capable of being made tranſparent by art; and hence that all our Tranſparent Ambers were not naturally ſuch. 3. That the fine gold yellow tranſparent ſort is entirely natural; the common methods of improving the tranſparency, weakening the colour. There are means of communicating to Amber a variety of colours: An excellent artiſt at Breſlau, by name Gottlieb Samuelſon, not only made opake Amber tranſparent, but tinged it red, blue, violet, of a purpliſh, green, and white; and cut it into brillants, necklaces, ear-pendents, bracelets, *&c.* in imitation of precious ſtones; as alſo into ſpectacles, microſcopes, priſms, burning lens's, *&c.* of which an account may be ſeen in the Breſlau collections. 4. That Amber clarified by art is always harder, and leſs electric, than in its natural untranſparent ſtate.

Embelliſhed by art.

Clarification. Schroder relates, that yellow Amber is made white by boiling in ſalt-water; and later writers have copied this account: On trial, however, ſalt-water is not found to have any ſuch effect. The workmen have two methods of clarifying Amber: One by ſurrounding the Amber with Sand in an iron pot, and cementing it with a gradual fire for forty hours; ſome ſmall pieces placed near the ſides of the veſſel, being occaſionally taken out for judging of the effect of the operation: The ſecond method, which is that moſt commonly practiſed, is, by digeſting and boiling the Amber about twenty hours with Rapeſeed oil, by which it is rendered both clear and hard: Treated in the ſame manner with Linſeed oil, it does not become clear. Sendelius informs us that he clarified pieces of cloudy Amber, by applying them to the flame of a candle, and rubbing them now and then with tallow; and that opake pieces, boiled with fiſh and with fleſh, ſhewed a diſpoſition to become clear. The moſt deſirable point in the manufactures of Amber would be, to find a method of melting ſmall pieces into a large one; but nothing of this kind has hitherto been diſcovered.

Enquiry into ſolvents for it. It is no ſmall piece of art to procure a total ſolution of Amber. I have tried twenty-five different methods; with alcalies, acids, oils, inflammable ſpirits, dulcified ſpirits, balſams, and other menſtrua; without being able perfectly to ſucceed. Hoffmann relates, that he has diſſolved Amber in two ways: One is by putting two parts of oil of Almonds and one of powdered Amber into a glaſs veſſel, and ſetting the veſſel in Papin's digeſter filled about one third with water: The cover of the digeſter being ſtrongly ſecured, and a moderate fire kept up for above an hour, the Amber was reſolved into a tranſparent gelatinous maſs, on the ſurface of which floated a little fluid oil. The other method is by boiling powdered Amber in water, with an equal weight of cauſtic Nitre; this corroſive alcali occaſioning, he ſays, almoſt all the Amber to be diſſolved. Theſe experiments I leave to their own merit, but muſt obſerve, that neither of them afford ſuch ſolutions as I was in ſearch of. Henckel has carried the affair much farther, pretending to prepare Amber, without burning, and without alcalies, ſo as to diſſolve totally in Spirit of Wine: Of this aſſertion we can form no judgment till the fact is produced.

Of

Of the common menſtrua, there is not one which totally diſſolves this concrete: In Papin's digeſter, the Amber perhaps is only ſoftened. Moſt liquors however extract ſome portion of it: A tincture made in vinous ſpirits is kept in the ſhops. Some have thought to promote the action of the ſpirit by fixed or volatile alcaline ſalts: But theſe kinds of additions give very little, if any, aſſiſtance to the ſpirit as a menſtruum, and are accompanied with an inconvenience of rendering the tincture unfit for the chirurgical uſes to which it is commonly applied. Highly rectified Spirit of Wine extracts of itſelf a ſufficiently ſtrong tincture from Amber: The admixture of alcaline ſalts deepens the colour of the liquor, without increaſing the quantity taken up. If the ſimple tincture is required to be more ſaturated with the Amber, it may be eaſily rendered ſo by drawing off a part of the ſpirit, which may be reſerved for the like uſes again, as being impregnated with the more ſubtile parts of the Amber. If the ſpirit be totally abſtracted, a balſamic or reſiniform extract is left: This is employed by ſome as an ingredient in compoſitions for pills. Water mixed with the tincture renders it turbid, but ſcarce any precipitation enſues; though in ſeveral books of pharmacy a magiſtery of Amber is directed to be prepared by this means. AMBER.

Amber melts and burns in the fire, and emits a ſtrong peculiar ſmell. Diſtilled, in a ſtrong heat, it yields a phlegm, an oil, and a particular ſpecies of volatile ſaline matter. The diſtillation is performed in earthen or glaſs retorts, frequently with the addition of Sand, powdered Flints, Bricks, Lime, elixated Aſhes, Bole, Loam, Pumice, Sea-ſalt, Coals, &c. Conſiderable differences are obſerved in the products according to the additions made uſe of: With ſome the Salt proves yellowiſh and dry, with others, browniſh or blackiſh, and unctuous or ſoft like an extract: With ſome the oil is throughout of a dark brown colour; with others it proves externally green or greeniſh; with elixated aſhes in particular, of a fine green, as I have found on repeated trials. The quantity of oil and phlegm is greateſt when coals, that of Salt when Sea-ſalt is uſed. The moſt common addition is ſand; of which two parts are mixed with two or one of Amber in coarſe powder, the mixture put into an earthen retort, of which it may fill ſomewhat more than one half, the neck of the retort wiped clean, the veſſel placed in a reverberatory furnace, a receiver luted on ſo as that the neck of the retort may reach down into its body, and the fire cautiouſly increaſed, leſt the Amber, melting like pitch, ſhould boil over into the recipient: At firſt a phlegmatic liquor diſtils, then a fluid oil, afterwards a thicker and more ponderous, and laſt of all, an oil ſtill more ponderous along with the Salt. Amber may be very commodiouſly diſtilled alſo without any addition, in glaſs retorts coated or uncoated; only greater caution is here required in the management of the fire, as the Amber is more apt to ſwell up and boil over by itſelf, than when divided by earthy or other matters: The recipient ſhould be large, and the retort only half filled with the Amber. Thoſe whoſe ſole buſineſs it is to diſtil Amber in Pruſſia, and whom long experience has taught the moſt advantageous methods of doing it, uſe no addition. The Engliſh chemiſts likewiſe diſtil their Amber without addition, and ſell the reſiduum to the japanners, who prepare from it the fineſt black varniſh. Hoffmann directs Amber-varniſh to be Diſtillation.

AMBER. made by melting the Amber and pouring it on an iron plate, then pulverizing, and putting it into a crucible, adding Linſeed oil that has been prepared with litharge, and laſtly pouring in Oil of Turpentine till the whole is diſſolved: The Engliſh method of making varniſh from the *Caput mortuum* is certainly more frugal than the melting of good Amber on purpoſe. The *Caput mortuum* of Amber diſtilled *per ſe* was in my experiments conſiderably light and ſpongy: When it looks like Colophony, we may preſume that there has been ſome miſmanagement in the proceſs; that either the fire has been too haſtily raiſed at firſt, or not ſufficiently continued.

Salt. In order more perfectly to collect the Salt, which is the moſt valuable product in this operation, the Pruſſian workmen frequently change the receiver during the diſtillation, and keep apart the phlegm and the light oil which ariſe at firſt. They purify the Salt by placing it for a time upon bibulous paper, which abſorbs a part of the oil; and changing the paper ſo long as it receives any oily ſtain. Where a further depuration is required, (for by this method we ſeparate only a part of the oil that adheres externally) the Salt is to be ſcraped out as clean as poſſible from the neck of the retort, or wherever elſe it has concreted, and waſhed off with water. The whole diſtilled matter is then to be mixed with a conſiderable quantity of hot water, the mixture well ſtirred together with a wooden ſpatula, the water, after ſettling, poured off, and freſh parcels of hot water added, to extract all the ſaline matter that may be retained by the oil: The Salt ſeparated at firſt is to be diſſolved in this liquor, the ſolution filtered, evaporated in glaſs veſſels to a proper pitch, and then ſet in the cold: The Salt will ſhoot into fine ſpongy yellow cryſtals, which may be gently dried upon bibulous paper: The remaining liqnor may be further inſpiſſated and cryſtallized afreſh, or evaporated to drineſs: The Salt obtained by theſe laſt proceſſes will turn out browner and browner, and is therefore to be reſerved for inferior purpoſes, or further purified, by repeating the ſolution, filtration, and cryſtallization. I have freed the Salt, by way of curioſity, ſo far from its oil, that it looked white as ſnow.

Salt of Amber, though it ariſes in diſtillation, and is diſtinguiſhed by the name of a volatile Salt, is not to be confounded with the volatile Alcalies. It is truly an acid Salt, changes Syrup of Violets red, effervesces with and neutralizes alcalies, and precipitates ſubſtances diſſolved in them. The *liquor cornu cervi ſuccinatus* of the ſhops is no other than a neutral ſaline liquor compoſed of this Salt and volatile alcalies: The method of preparing it in the greateſt perfection is, to diſſolve pure Salt of Amber and Salt of Hartſhorn ſeparately in diſtilled water, and add the alcaline ſolution to the other by a little at a time, till the ſaturation is compleated: By this means we obtain a neutral ammoniacal Salt of a peculiar kind. The nature and qualities of Salt of Amber are as yet very little known. Its acid ſeems to approach neareſt to the vitriolic; for Oil of Vitriol, which expels the nitrous, marine, and acetous acids in form of fumes from alcalies or earths with which they have been combined, extricates no vapour from Salt of Amber, nor from combinations of it with alcaline Salts. When fixed alcalies however have been neutralized with Salt of Amber, and reduced into cryſtals, they ſtill effervesce with the vitriolic acid; which, if the acid of Amber was truly vitriolic, they could not

not do (*y*). We very rarely meet with any genuine Salt of Amber in the shops; powdered Amber, Creme of Tartar, Sugar, Sal ammoniac, Sea-salt and other substances, being commonly mixed with it, and a good quantity of oil left in it, the better to conceal these additions. AMBER.

The

(*y*) *Salt of Amber.*] Though Oil of Vitriol unites with this acid Salt without effervescence or fumes, it does not follow that its acid is of the vitriolic kind. Oil of Vitriol, dropt on Tartar, is imbibed with equal quietness, yet no one presumes from hence, that the acid of Tartar is vitriolic . . . . Mr. Bourdeline endeavours to prove, that the acid of the Salt of Amber is marine *. A genuine Sea-Salt is indeed obtainable from some sorts of Amber, as I have oftener than once observed; but this does not affect the volatile Salt of the Amber, the Sea-salt being equally procurable after the separation of the volatile Salt, and the volatile Salt giving no marks of any thing marine. As large quantities of this Bitumen are found in the sea, we need not be at a loss to account for its accidental impregnation with marine Salt . . . . Mr. Pott † has given a curious sett of experiments upon this singular Salt; from which its acid appears plainly to be essentially different from the three mineral acids, and to approach nearest to those of the vegetable kingdom. We shall here give an abstract of the principal observations he has made upon this Salt.

Salt of Amber requires a large quantity of water for its solution. In the first crystallization it shoots into spongy flakes, in colour resembling brown Sugar-candy: The crystals which succeed prove darker and darker coloured. On repeating the depuration, the first crystals appear at top of a clear yellow or whitish colour, in form of long needles or feathers; at bottom darker and more irregular, as are likewise the crystals which shoot afterwards. The crystals neither liquefy nor become powdery in the air: Rubbed, they emit a pungent smell like that of radishes, especially if warmed a little; their taste is acid, not in the least corrosive, but with a kind of oily pungency.

This Salt kept in the heat of boiling water loses nothing of its weight, and suffers no alteration. In a great heat it melts like oil; after which, a little oily acid liquor arises, then oily striæ appear in the lower part of the retort, and the Salt sublimes into the neck, partly in the form of a dark yellow butter, and partly in that of feathers, a black coaly matter remaining at the bottom; so that by this process a part of the Salt is destroyed.

Oil of Turpentine has no action on this Salt. Highly rectified Spirit of Wine gains from it a yellow colour in the cold, and on the application of heat dissolves a considerable quantity, but deposites great part of it on cooling: The Salt thus deposited is somewhat whiter than before, but still continues sensibly yellow. The dulcified or vinous Spirit of Sal ammoniac dissolves it readily, without effervescence, into a yellow liquor: If the Salt was foul, the solution proves of a red colour: On burning off the vinous spirit, a neutral liquor remains.

A solution of Salt of Amber in water, saturated with a pure fixed alcaline Lixivium, yielded on inspissation a saline matter, which would not crystallize, and which, when exsiccated by heat, deliquiated in the air, leaving a considerable portion of an unctuous earthy matter: Being again gently inspissated, it left a browniſh Salt, very soluble, weighing one half more than the Salt of Amber employed: This Salt effervesced with the nitrous and vitriolic acids: The vapour which exhaled was not acid, but somewhat sulphureous and oily. On repeating the experiment, and fully saturating the Alcali with the Salt of Amber, the neutral Salt made no effervescence with those acids. This Salt did not perfectly melt before a blowpipe: Continued in the fire for some time, it effervesced with Aqua fortis, a mark that it had now lost some of its acidity. In distillation it yielded a bitter oily alcalescent spirit, much resembling the Spirit of Tartar; and towards the end an empyreumatic oil: The residuum elixated, yielded the alcaline Salt again of a brown colour.

Salt of Amber mixed with volatile spirits, raises a strong effervescence, and after suffi-

* Mem. de l'acad. de Sciences de Paris. An. 1742.

† Mem. de l'acad. de Sciences de Berlin. An. 1753.

cient

AMBER. Oil. The Oil of Amber is rectified by diſtilling it over, either by itſelf, or with different additions, as burnt Bones, Lime, elixated Aſhes, Chalk, tobacco-pipe Clay, Potaſh, &c. The beſt method is to diſtill it with common water, and

cient ſaturation, forms with them a neutral, ammoniacal, oleaginous liquor; which totally ariſes in diſtillation in a fluid form, except that a ſmall portion of a penetrating oily ſaline matter concretes towards the end.

On diſtilling Salt of Amber with an equal quantity of common Sal ammoniac, an acid marine ſpirit came over, of a very ſtrong ſmell, and a brown colour: Afterwards a little white Sal ammoniac ſublimed: At length aroſe ſuddenly a large quantity of a fuliginous or bituminous matter, leaving behind a ſmall portion of a like ſhining black ſubſtance. The coaly matter was conſiderably more in quantity than the Salt of Amber employed——On treating it with Nitre, red nitrous vapours aroſe, and then the mixture detonated with violence . . . . . A mixture of it with Borax frothed and ſwelled up much more than Borax by itſelf, and on raiſing the fire, yielded only ſome oily drops; the acid being deſtroyed by this Salt, as by fixt Alcalies and Quick-lime.

Spirit of Sea-ſalt poured upon one fourth its weight of Salt of Amber, made ſcarce any ſolution in the cold: On the application of heat, nearly the whole coagulated into the conſiſtence of a jelly. In diſtillation the Spirit of Salt aroſe firſt, then almoſt the whole of the Salt of Amber, partly like firm butter, partly like long ſtriated plumous Alum, very pure, and of a fine white colour, its oily matter being changed into a coal at the bottom. The Salt thus purified, makes no precipitation in ſolution of Silver, and conſequently retains nothing of the marine acid, nor does it precipitate ſolution of Quick-lime made in Spirit of Salt, and conſequently contains nothing vitriolic. If any of the mineral acids was contained in this Salt, it could not here eſcape diſcovery; the oil, which in the rough Salt is ſuppoſed to conceal the acid, being in this proceſs ſeparated.

Aqua fortis poured upon one fourth its weight of Salt of Amber, extracted a yellowiſh colour in the cold, but diſſolved little: On the application of heat, the whole diſſolves into a clear liquor without any coagulation: If the Salt is very oily, the ſolution proves red. In diſtillation, greateſt part ariſes in a liquid form, with only a ſmall matter of concrete Salt. The ſpirit does not act upon Gold, but diſſolves Silver and Quickſilver as at firſt; a proof, that it has received no marine acid from the Salt of Amber.

Oil of Vitriol being added to twice its weight of Salt of Amber diluted with a little water, a moderate fire elevated an acidulous liquor, which appeared to proceed from the Salt of Amber; for its making no change in ſolution of fixed Sal ammoniac ſhewed it not to be vitriolic. On continuing the diſtillation by a ſtronger fire, greateſt part of the Salt ariſes undeſtroyed, and the oil of Vitriol along with it, a black, light, porous earth remaining.

Equal parts of Quick-lime and Salt of Amber gave over in diſtillation only an acidulous phlegm: The reſiduum, elixated with water, yielded a ſolution of the Lime in the acid of the Amber, reſembling a ſolution of the ſame earth in vegetable acids, precipitable by alcaline Salts and by the vitriolic acid. Lime added to a watery ſolution of Salt of Amber, diſſolves with ſome efferveſcence, after which the whole coagulates into the conſiſtence of a jelly: This diluted with warm water, proves ſimilar to the foregoing ſolution.

Solution of Salt of Amber makes no precipitation in ſolutions of Silver or Quickſilver. It diſſolves Zinc, as all acids do: Fixed Alcalies precipitate the Zinc: The volatile do not, and when a ſufficient quantity of the volatile has been added, the fixed make no precipitation. It acts exceeding ſlowly and difficultly upon Copper, but corrodes calcined Copper in a ſhorter time. It ſoon corrodes Iron, by coction, into a Crocus, and diſſolves a part into a liquid form: The ſolution has little colour, but alcaline Salts readily diſcover that it holds Iron, by rendering it turbid and whitiſh, and throwing down a conſiderable quantity of a greeniſh calx. A ſolution of this Salt does not appear to act upon Lead or Minium by long digeſtion; and in this reſpect it differs from the vegetable acids.

and repeat the diſtillation ſeveral times with freſh parcels of water: By this method we obtain a clear limpid oil, a large quantity of thick pitchy matter remaining behind. I have rectified Oil of Amber to ſuch a degree, that ſcarce any one could tell what kind of fluid it was, as it mingled with water, with Spirit of Wine, with an acid, with expreſſed oils, with diſtilled oils, and almoſt with all liquors. Spirit of Wine digeſted with the unrectified oil, does not diſſolve it, but extracts ſome of its finer parts, leaving a conſiderably thick pitchy ſubſtance——In the ſhops it has been cuſtomary to impregnate volatile ſpirits with Oil of Amber, by mixing powdered Amber with the ingredients from which they are diſtilled: Commonly one part of Amber, one of Sal ammoniac and three of Quick-lime, are mixed together, and committed to diſtillation with a proper quantity of Spirit of Wine. Theſe *ſuccinated Spirits of Sal ammoniac*, or *Sal volatile oleoſum ſuccini*, may likewiſe be made extemporaneouſly, by diſſolving rectified Oil of Amber in the vinous Spirit of Sal ammoniac prepared with Quick-lime. AMBER.

Different ſorts of Amber differ greatly in the produce of Salt and Oil. Sixteen ounces of the common coarſe untranſparent Amber found in the ſea (the ſort generally made uſe of in the ſhops) yielded ſomewhat more than eleven ounces and ſix drams of Oil, four drams and a half of Salt, nearly an ounce and a half of water, and ſcarcely an ounce of *Caput mortuum*. Hartman relates, that white Amber yields more Salt than the yellow; that from a pound of the firſt he obtained four drams, and from the ſame quantity of the latter only one. Another Pruſſian obſerves, that the *Sandſtein* yields moſt Salt, the *Schlug* leſs, and the *Ferniſs* ſtill leſs. I am informed by a friend, that from a pound of the *Sandſtein* he has gained from ſix drams to an ounce of Salt; but I preſume the Salt was either very oily, or was diſtilled with additions. I repeated the experiment on that kind of Amber with great care, and obtained from thirty-two ounces, nine drams of good pure Salt, and nearly twenty-four ounces of Oil. Quantities of Salt and Oil.

II. AMBERGRIS.

AMBERGRIS, *Ambragriſea*, is a marine Bitumen, about the conſiſtence of wax, of a laminated ſtructure, as if the maſs was formed by a ſucceſſive appoſition of matter, ſometimes found in the waters of the ſea, ſometimes thrown out upon the ſhores, and ſometimes met with in the ſtomachs of whales and other fiſhes, frequently intermixed with little bones, claws of birds and other like matters. Theſe circumſtances have given riſe to many ridiculous opinions concerning its origin, as its being the excrement of birds or fiſhes, generated in the ſtomachs of fiſhes like Bezoar, being a ſort of wax produced by bees upon rocks, *&c.* AMBERGRIS. Natural hiſtory.

The greateſt quantities of Ambergris are met with in the Eaſt-Indies, about the iſland Madagaſcar, the Molucca iſlands Mauritius and Neykotarres, the weſtern Sumatra iſlands, about the iſland Borneo and Cape Commorin near Malabar, and on the Ethiopian coaſt, which, from Solafa to Brana, is ſaid to be very rich in Ambergris. Pieces are ſometimes met with of an extraordinary ſize. Chevalier and Garcias mention a piece weighing no leſs than three thouſand pounds, found in 1555 at Cape Comorin, and ſold for Aſphaltum; and Extraordinary pieces.

AMBERGRIS. Joh. Hugo von Lindſchott informs us, that a maſs of thirty quintals was found at the ſame Cape. Monardes and Franciſcus Hernandez mention a piece of an hundred pounds; Garcias, one as large as a man, and another which was ninety palms in length and eighteen in breadth; Montanus, one of a hundred and thirty pounds; and Kempfer, one exceeding that weight, found in his time in the province of Kinokuni in Japan. The Dutch Eaſt-India company purchaſed of King Tidori in 1693, for eleven thouſand rixdollars, a piece of Ambergris weighing one hundred and eighty-two pounds, which was kept many years at Amſterdam, and ſeen by thouſands, but afterwards broken and ſold by piece-meal: It was of the ſhape of a tortoiſe, and meaſured five foot eight inches by two foot two: Nicholas Chevalier has given a particular deſcription of it in a treatiſe printed at Amſterdam in 1700. Mr. Godfrey, a chemiſt in London, informed me that a merchant there had a maſs of ſix hundred ounces, and that another had one of ſixty pounds.

Differences. Ambergris is of various colours, aſh-coloured, whitiſh, yellowiſh, blackiſh-grey, brown, black, ſtreaked and ſpotted. The pieces which have been ſwallowed by fiſhes are the leaſt eſteemed, as receiving an ill ſmell from the animal. The quite blackiſh and the quite whitiſh are to be rejected; and thoſe which are ſmooth and of an uniform texture, we may ſuſpect of being counterfeits. The aſh-grey-coloured Ambergris, with whitiſh, blackiſh, and yellowiſh ſtreaks or ſpecks, is accounted the beſt, eſpecially when intermixed with beaks of birds, bits of cuttle-bone, or other like matters; not that theſe are eſſential to the Ambergris, but as they are marks of its genuineneſs. The beſt Ambergris is light, like wax to the touch, crumbly, yet ſomewhat tenacious, ſo as to ſtick to the mortar or peſtle; it has an agreeable ſmell, but no remarkable taſte: It eaſily melts in the fire, takes flame from a candle, and burns away without intermiſſion.

General properties.

Sophiſtications. Ambergris is counterfeited or adulterated with Wax, Reſin, Storax, Benzoine, Amber, Labdanum, Muſk, Civet, Aloes-wood, old decayed Aſh-wood, Rice Meal, Tree Moſs, and other like ſubſtances. Theſe abuſes are eaſily detected. The counterfeit ſorts are commonly uniform throughout, both in colour and texture, like a paſte or maſs of pills, which the genuine Ambergris never is. The former commonly ſoften ſooner in the warm hand, and never have the true Ambergris ſmell, no art being able to perfectly imitate this. The ſmell is moſt readily diſtinguiſhed in melting the Ambergris on burning coals, or in a Silver ſpoon over a candle or in the flame: It ſmells at laſt like burning Amber, but not ſo ſtrong. The true Ambergris bubbles up in melting, and after fuſion appears brown. Some judge of its genuineneſs, from the appearance of a matter like melted Reſin upon piercing the maſs with a red-hot needle, or other ſlender inſtrument. Menſtrua likewiſe afford ready methods of diſtinguiſhing the genuine from the ſophiſticated.

Chemical characters. Ambergris melts in boiling water like a Reſin, and communicates to the liquor a little of its ſmell, which ariſes along with the water in diſtillation. It

Solution. diſſolves in Linſeed oil if the Ambergris be previouſly melted, and the oil freed from water. It has been hitherto looked upon as exceeding difficultly, and not at all totally ſoluble in Spirit of Wine; the Spirit being ſuppoſed to extract only a ſmall part, as it does from Amber. I have found however, that this

Menſtruum

Menſtruum may be made to diſſolve Ambergris both readily and totally. If Ambergris, broke in pieces, be put into twelve times its weight of a good tartarized Spirit of Wine, or of a plain highly rectified ſpirit; the ſpirit will extract little till it begins to boil, but will then quickly diſſolve the whole of the Ambergris except its impurities. If the ſpirit is impregnated with any eſſential oil, whether by drawing it over from oily vegetables, or by adding the oil itſelf, it will diſſolve Ambergris more readily, and in a leſs degree of heat than would otherwiſe be neceſſary: I have tried likewiſe the rectified Oil of Amber, and found that this, as well as the vegetable diſtilled oils, promoted the action of the ſpirit; but that expreſſed oils, recommended by Schroder, had no effect. The tincture made in tartarized ſpirit is of a deep reddiſh colour; that made in pure ſpirit has ſcarcely any colour. The reſiduum appears of a large volume, though when dried, it proves to be only a very ſmall quantity of a fine earthy matter, amounting when the Ambergris is free from viſible impurities, to a grain or two upon two ſcruples. It is probable that Ambergris has often been diſſolved, though the paleneſs of the ſolution, and apparent bulk of the reſiduum, have induced the operator to think otherwiſe. In keeping the tincture or ſolution, if the veſſel is looſely ſtopt, ſo as to ſuffer a part of the Menſtruum to exhale, a proportionable quantity of the Ambergris precipitates, in form of a white unctuous ſubſtance like tallow, ſoluble again upon adding more ſpirit. Lemery looked upon this as wax, and hence endeavoured to prove that Ambergris proceeded from the labour of bees——The dulcified Spirits of Vitriol, Nitre and Sea ſalt, and the dulcified or vinous Spirits of Sal ammoniac made both with Quick-lime and with fixed alcaline Salts, digeſted with Ambergris, did not diſſolve it, and extracted extremely little: It was obſerved that in the digeſtion with dulcified Spirit of Vitriol, and with this only, the little it did extract concreted about the ſides of the glaſs into ſmall ſaline cryſtals. AMBERGRIS.

Dr. Grimm gives an analyſis of Ambergris by diſtillation in the *Ephemerides naturæ curioſorum*. An ounce diſtilled in a glaſs retort, yielded firſt an aqueous liquor, then, as he calls it, a ſpiritual liquor, afterwards a yellow oil with a ſmall quantity of volatile Salt, a pitch-like matter remaining in the retort. He obſerves, that the liquor, the oil, the ſalt, and the reſiduum, were all ſimilar to thoſe obtained from Amber, except that the oil was in ſmell more agreeable——I repeated this experiment with a dram of Ambergris, and obtained the ſame products, except as to the pitchy reſiduum, ſcarcely one grain of duſt or earthy matter being here left, probably from the fire having been longer continued or raiſed higher than in Grimm's experiment. The quantity of oil was two ſcruples and a half, of phlegm five grains, and of Salt two grains. Both the oil and the ſalt agreed with thoſe of Amber. Diſtillation.

The analyſis of Ambergris confirmed me in the opinion that this concrete, whoſe origin was formerly ſo much diſputed, is truly a Bitumen of the Amber kind; and accordingly I communicated my obſervations to the Royal Society in London, in the year 1729. The facts were called in queſtion by ſome of the Engliſh chemiſts; and about three years after, Sir Hans Sloane ſent me an account of the experiments made by Mr. Brown and Mr. Godfrey. The former diſtilled Ambergris with tobacco-pipe clay, and obtained, firſt a clear

phlegm, next a ſpirit in colour reſembling beer, afterwards a darker coloured oil, and at laſt a black balſam: The oil and balſam were nearly the ſame with thoſe of Amber, but no volatile Salt was obtained. Mr. Godfrey made three diſtillations of Ambergris, one by itſelf, another with ſand, and the third with powdered glaſs. On rectifying the liquors diſtilled with ſand, he had more than half the weight of the Ambergris, of a limpid, balſamic, and bituminous oil, with a phlegm which taſted ſouriſh, but leſs ſo than Vinegar.

Theſe experiments, inſtead of being as was ſuppoſed, contrary to mine, are entirely agreeable to them, and manifeſt a ſtrong reſemblance betwixt Ambergris and Amber in regard to their conſtituent parts. The difference in the ſeveral experiments is this: I obtained from ſome pieces of Ambergris a ſmall portion of a volatile acid Salt; the piece examined by Mr. Brown yielded no concrete Salt; Mr. Godfrey's yielded no Salt, but an acidulous liquor, which was a ſolution of the Salt in phlegm.

Uſes. Ambergris is uſed principally as a perfume, in balſams, ſnuffs, dentifrices, hairpowders, waſhballs, *&c.* It was formerly held in ſome eſteem as a medicine, and ſaid to poſſeſs nervine, analeptic, aphrodiſiac, cephalic and other virtues, but is at preſent little regarded. A tincture of it is ſometimes prepared with Spirit of Roſes: This Spirit has no advantage as a menſtruum for the Ambergris above ſimple Spirit of Wine, though it may in ſome caſes be an uſeful addition in point of ſmell, ſolutions of Ambergris by itſelf having very little ſmell (*z*).

JEWS PITCH.

JEWS PITCH. Where found. JEWS PITCH, *Aſphaltum*, *Bitumen Judaicum*, *Bitumen Babylonicum*, is found in a ſoft or liquid ſtate on the ſurface of the Dead-ſea, and by age grows dry and hard. The ſame kind of Bitumen is met with likewiſe in the earth,

(*z*) *Additional article.*] In the Swediſh Tranſactions for the year 1743, there is an account of another kind of marine Bitumen, which was found in conſiderable quantity in Finland, of a white colour, reſembling tallow, but more brittle; in ſmell ſomewhat like roaſted meat. It feels unctuous, makes paper greaſy, ſwims on water, burns with a fine blue flame and copious ſmoke, and leaves a blackiſh brown ſubſtance like Reſin, flexible betwixt the teeth, and not ſoluble by the ſaliva. Held over the fire it melts, becomes immediately brown, and ſeparates into a thin part like oil, and a thicker which ſticks to the veſſel: Both adhere firmly to the veſſel when grown cold. Oil of Almonds does not act upon it in the cold: By the aſſiſtance of a boiling heat it diſſolves greateſt part. Strong tartarized Spirit of Wine diſſolves it; but what is remarkable, the circumſtance on which the ſolution of Ambergris in that menſtruum depends, impedes the ſolution of this concrete: As ſoon as the ſpirit begins to boil, a part of the Bitumen falls undiſſolved to the bottom. The ſolution has little colour: In evaporation the Bitumen is depoſited all round the veſſel, nearly in its original appearance.

Specific gravities of ſundry Bitumens.

The above white marine Bitumen	0,770
Ambergris	0,789
Tranſparent yellow Amber	1,085
Jet	1,180
Staffordſhire Pitcoal	1,240*
Newcaſtle Coal	1,270†
Scotch Coal	1,300‡
Aſphaltum	1,400‖
Water	1,000

* Oxford Society. † Mr. Labelye. ‡ Boyle. ‖ Boyle.

earth, in other parts of the world, in China, America, and in some places of Europe, as the Carpathian hills, France, Neuchatel, &c. There are several kinds of Jews Pitch in the shops, but none of them are the genuine sort, and have little other title to their name, than their being artificially compounded by Jews. They are all firm, solid, and of a blackish colour, but different in degree of colour. I examined three sorts, the blackish-brown native Bitumen, the best officinal sort, of a blacker colour and somewhat bright, and an inferior one, black and gloffy like common Pitch. Jews Pitch. Sorts.

The native Bitumen has no smell. It is not acted upon by water, nor highly rectified Spirit of Wine, nor oil Olive, nor the essential oils of Aniseed or Turpentine. In the fire it grew red-hot, like Turf or a piece of red-hot Iron, and when cold fell into powder. Held over the fire in a proper vessel, it did not melt, but crumbled as before, and emitted a vapour which took flame on the approach of a piece of lighted paper. Four ounces distilled in a glass retort, yielded only three drams of an empyreumatic oil, with a little phlegm: The oil greatly resembled the native Petrolea, but had somewhat more of the empyreumatic taint. The *Caput mortuum* weighed three ounces and a half: Two ounces of this were reduced by calcination to one ounce and six drams; which yielded on elixation with water, seven grains of an alcaline substance but not a pure alcaline Salt. It was observable in the distillation, that the bituminous or oily matter, in separating from the earthy parts, visibly melted, and then arose in invisible vapours, whereas in open vessels, there was no appearance of fusion, the oil immediately exhaling in the air. Experiments on the true Asphaltum.

The best officinal Asphaltum has a disagreeable smell, like that of Garlic or Asa fetida. A small portion of it is taken up by rectified Spirit of Wine, above two scruples of spiritous extract being obtained from two ounces. Water dissolves nothing, but elevates a part of its Garlic flavour in distillation. It dissolves both in oil Olive, and in the distilled oils of Aniseed and Turpentine, and unites in the fire with Pitch and Wax. Distilled Vinegar and Spirit of Salt have no action on it, the Asphaltum swimming untouched on the surface. It gives a yellowish tinge to Spirit of Nitre, and partly swims on the surface, and partly falls to the bottom. It gives a deeper tincture to Spirit of Vitriol, and totally swims. It sinks in caustic alcaline Lixivia, and tinges them yellowish, but floats on simple alcalies, and to these also communicates a tincture. Vinous Spirit of Sal ammoniac seems to extract the deepest colour; the watery spirit gains but a very slight one: In the former, the Asphaltum totally sinks, in the latter a part of it swims. Four ounces yielded in distillation, two ounces five drams and one scruple of oil, and only about two scruples of phlegm, above an ounce of *Caput mortuum* remaining. The oil was thickish, of a dark brown colour, and had a strong smell and taste like those of Garlic: It arises first in white, then in yellow, and at last in darker coloured vapours: As soon as the yellow fumes appeared, the matter in the retort begun to melt. Nothing saline appeared in the distillation or could be extracted by hot water from the oil, or from the calcined *Caput mortuum*. on the best officinal Asphaltum.

The inferior Pitch-like Asphaltum melted as easily as common Pitch. From four ounces I obtained almost full three ounces of dark brown oil, and a small portion, about half a scruple, of phlegm, the residuum making up the fourth ounce: on an inferior sort.

Jews Pitch. ounce: Scarce any thing-ſaline could be diſcovered in the reſiduum by calcination and elixation with water. Two ounces being digeſted in rectified Spirit of Wine, the filtered liquor left on diſtillation fifteen grains of extract: The ſpirit drawn over ſmelt of Garlic or Aſa fetida. Whilſt another parcel was digeſting in rectified Spirit, no viſible ſolution being made, I dropt in an eſſential oil; it was oil of Savin that came firſt to hand: The ſpirit now begun to act, and by the time an hundred drops had been added, appeared conſiderably tinged: The quantity of Aſphaltum was a ſcruple, and of ſpirit two drams. The ſolution was here effected by virtue of the oil, and not of the ſpirit: For upon digeſting another ſcruple of the powder with a dram of the oil of Savin, nearly all the Aſphaltum was ſoon diſſolved: On adding rectified Spirit of Wine, it was thrown down again, and the ſpirit ſcarcely appeared tinged.

From theſe experiments it is evident, that the officinal Aſphalta are very different from the genuine natural bitumen; and as they are a medly of we know not what ingredients, their medicinal uſe begins to be deſervedly laid aſide, notwithſtanding the diſcutient, reſolvent, pectoral and other virtues attributed to this bitumen by the ancients. The Aſphalta of other countries appear to be as little genuine as ours: In Du Hamel's hiſtory of the French Academy of Sciences, we find that two pounds of the French Aſphaltum yielded fourteen ounces of oil; from whence we may preſume, that this was one of the oily artificial compoſitions, the native Aſphaltum not affording one fourth ſo much.

Uſes. This bitumen was formerly uſed in embalming the bodies of the dead. At preſent the thick and ſolid bitumens are employed in Egypt, Arabia, and Perſia, as Pitch for ſhips; and the fluid ones, for burning in lamps, and for varniſhes. Some writers relate, that the walls of Babylon, and the temple of Jeruſalem, were cemented with Bitumen inſtead of mortar. Thus much is certain, that a true native Bitumen, that for inſtance which is found in the diſtrict of Neuchatel, proves an excellent cement for walls, pavements and other purpoſes, uncommonly firm, very durable in the air, and not penetrable by water. The watch and clock-makers uſe a compoſition of Aſphaltum, fine Lamp-black, and oil of Spike or Turpentine, for drawing the black figures on dial-plates: This compoſition is prepared chiefly by certain perſons at Augſburg and Nurenberg.

IV. PIT-COAL.

Pit-Coal. Natural hiſtory. PITCOAL, *Carbo foſſilis*, *Anthrax*, *Lithanthrax*, is a bituminous foſſil, found in ſeveral parts of the world, moſt plentifully in England and Scotland, from whence it is exported, in large quantities, into other countries, for the common purpoſes of fuel. The moſt conſiderable Coal-pits are in the neighbourhood of Newcaſtle, and the coals dug here are likewiſe accounted the beſt, though ſome of the Scotch ſorts render their ſuperiority diſputable. Some other parts of England, as Somerſetſhire, Staffordſhire, *&c.* afford alſo plenty of Coals. Next to the Engliſh and Scotch, the French are held to be the beſt, particularly thoſe of St. Etienne foreſt, and Auvergne: There are Coals likewiſe in other parts of France, as Burgundy, Nivernois,

Nivernois, &c. thoſe of St. Dizier are the worſt. In Kircher, the German ephemerides, the Breſlau collections, &c. we find accounts of Pit-coal dug in the iſland Elva, in Sicily, and in different places of Italy; between Neuſol and Chremnitz; in the dutchy of Wurtemberg; at Altdorff near Nuremberg, and at Kalterſnortheim on the river Fulda in Eiſenach; in the iſland Bornholm, in Bohemia, Heſſia, Saxony, &c. It is ſaid that there are external marks, by which the tracts of land that abound with Pit-coal may be diſtinguiſhed: That the ground itſelf is either manifeſtly bituminous, or ſeldom has any Dew: That the Snow melts ſooner than in other places: That the trees are ſmall, and that their roots contain a bituminous juice: And that the air, in hot ſummer weather, is highly ſulphureous. PIT-COAL.

There are many different ſorts of Pit-coal; light and heavy; ſpongy and compact; brittle and firm; earthy and ſtony; of a more or leſs diſagreeable ſmell in burning: The vapour of all the ſorts is generally diſagreeable to thoſe who are unaccuſtomed to it. The French divide Pit-coal into two kinds, which they diſtinguiſh by different names: The light and brittle are called *Charbons de terre*, Earth-coals; the ponderous and compact, *Charbons de pierre*, Stone-coals. There is a hard, light ſort, very compact, ſmooth and equal; not ſtaining the fingers like thoſe commonly uſed for fuel; capable of being poliſhed, filed, cut, and turned in a lathe; uſually made into ſnuff-boxes, bracelets, and other elegant toys; called *Gagates* and *Succinum nigrum*, jet or black Amber. The fineſt of this kind is met with in England, particularly in Staffordſhire and in Cornwall. This appears to be a ſpecies of Bitumen diſtinct from the common Pit-coal, and to be rather a bituminous Wood than an original Bitumen: It looks like fine black ebony. In the fire, it ſooner catches flame than the common Coals, and burns rather with a bituminous than ſulphureous ſmell. Some pieces, in which the woody matter prevails, ſmoke but do not flame: Theſe are not to be looked upon as a Bitumen of this ſpecies. See Boyle's treatiſe on the origin of gems. Different ſorts. Jet.

The beſt Coals are thoſe which ſooneſt take fire, burn longeſt, and give the greateſt heat. The characters laid down in the Œconomical lexicon as marks of good Coals, their emitting a black ſmoke, yielding a watery moiſture on being preſſed, and not burning without bellows or ſtrong wind, are marks not of good, but of the bad German Coals. Good Pit-coal yields a thick yellowiſh ſmoke, gives out nothing upon expreſſion, unleſs moiſtened, and burns without any ſtrong impulſe of air. Marks of goodneſs.

The beſt ſort of the Halle Pit-coal, digeſted and boiled in Water and in rectified Spirit of Wine, gave out nothing conſiderable to either. Forty-eight ounces, diſtilled in a glaſs retort, with a fire gradually increaſed, yielded two ounces ſeven drams of phlegm; two ounces and one dram of a thin fluid oil; and one ounce of a thick, tenacious, ponderous, pitchy oil, which ſtuck in the neck of the retort: The reſiduum weighed forty-one ounces ſeven drams. Nothing of the acid Salt like that of Amber, which Hoffmann obtained from Pit-coal, was here diſcovered: The diſtilled liquors gave marks rather of an urinous and ammoniacal matter, changing Syrup of Violets greeniſh, and emiting an urinous odour on the admixture of fixed alcaline Salts or quicklime. The *Caput mortuum*, calcined and elixated with Water, yielded a ſmall Experiments.

PIT-COAL. ſmall portion of ſaline matter, not alcaline but rather aluminous, a ſolution of it being rendered turbid by fixt alcaline Salts, and depoſiting an earthy precipitate. The Oil aroſe in yellow fumes, and ſmelled conſiderably ſulphureous; it ſomewhat ſtained poliſhed Silver, but the ſtains were eaſily rubbed off: That which diſtilled at firſt was light, and ſwum on Water; the ſucceeding parcels proved more and more groſs and ponderous, and at laſt ſunk. The Coals, during the diſtillation, looked like melted pitch——The coarſe ſtony Pit-coal of Halle yielded no oil: From two ounces were obtained only a dram of liquor, of a ſtrong ſulphureous ſmell; and about half a dram of a yellow ſublimate, greatly reſembling common Sulphur: The reſiduum weighed one ounce, ſix drams and a half.

Uſes and inconveniencies. Pit-coal, an excellent fuel for common uſes, is for many purpoſes unfit. It cannot be employed for the running down of Iron or other ores, which are ſmelted in contact with the fuel; not, as ſome have ſuppoſed, that the foſſil Coal does not give ſufficient heat; but from its ſulphureous ſubſtance corroding and ſcorifying the metal, or rendering it brittle; whilſt vegetable Coals ſupply only the ſimple inflammable principle neceſſary for receiving the metal into its metallic form. Thoſe which are in any conſiderable degree ſulphureous, render Iron brittle even on the blackſmith's forge. Nor are foſſil Coals proper for fuſion in crucibles, as they melt and cake about the veſſel, and endanger its cracking: The glaſs-makers in England have been greatly diſtreſſed by this ill quality of Pit-coal, and the ſcarcity of wood; inſomuch as to proffer a reward of ten thouſand pounds to thoſe who diſcovered a compoſition for pots that ſhould beſt ſtand Pit-coal fires——In Brabant, Liege, Cologn and other places, the ſmall Coals, which would burn away too ſoon or fall through the grate, are commonly reduced into powder, mixed with loam, and formed into cakes or maſſes, which are employed with good advantage for the ſame purpoſes as large Coals——The ſmoke of Pit-coal has been generally ſuppoſed prejudicial to health: Hoffmann appears to be the firſt who has maintained the contrary, and I am entirely ſatisfied of the juſtneſs of his opinion. I never obſerved the leaſt prejudice from them during my long reſidence in London; and it may be obſerved, that even when we are immediately expoſed to the ſmoke, it does not affect the eyes like the ſmoke of wood.

SECT.

SECT. V.

WATER.

WATER is an univerſal fluid, diſtributed in abundance through all the kingdoms of nature, but referred moſt properly to the mineral, from its being collected in ſuch immenſe reſervoirs in the earth. It is diffuſed through the atmoſphere in the warmeſt and drieſt weather: Alcaline Salts grow moiſt in the air in the greateſt droughts: Metallic veſſels, cooled by the application of the ice or ſnow and made thoroughly dry, collect watery drops on being brought into a warm air, by condenſing the aqueous vapours that imperceptibly floated in it. WATER. Diffuſed thro all the kingdoms of nature.

Water is the baſis of all liquids. Not only acid, alcaline, vinous Spirits, but Oils themſelves, owe to Water their liquid ſtate. It is an ingredient in the compoſition of all animal and vegetable bodies, even of their hardeſt and moſt ſolid parts; as alſo in that of all minerals, unleſs the precious ſtones and pure metals be exceptions. Some of the cryſtalline Salts in particular, as green Vitriol and Alum; though ſolid, hard, and to appearance perfectly dry; are found upon experiment to abound with Water; and to loſe their ſolidity and cryſtalline form upon ſeparating their Water, whether by the force of fire, or more gradually by the natural gentle warmth of the atmoſphere. When Water is conſidered as entering the compoſition of bodies, or extracted from them by art, it is commonly called by the chemiſts phlegm. The baſis of all liquids, &c.

There is a conſtant circulation of Water from one region of nature to another. This fluid is continually exhaling by the ſun's heat, from the ſurface of the ocean, from rivers, ſprings and ponds, from the earth, from animals and vegetables, into the air; and being there accumulated, and condenſed, deſcends again, in rain, ſnow, hail and dew; affording freſh ſupplies to the mineral ſources, to the animal and vegetable worlds. By this uninterrupted circulation, the fluid itſelf is preſerved from putrefaction; and all the ſublunary creation recruited with ſucceſſions of ſweet Water. Conſtant circulation of water.

Water exhales more eaſily from ſome ſubſtances than from others; from Stones, Sands, Bolar-earths, Reſinous woods, more eaſily than from ſaline, unctuous, gelatinous, mucilaginous juices, and ſlimy earths: Hence there are ſoils, which retain moiſture longer than others. It carries off in its exhalation ſundry ſubſtances, which of themſelves would not ariſe: Some bodies, which by themſelves abide fixed and unaltered in the moſt intenſe degrees of fire, vitriolated Tartar for inſtance, exhale into the air along with the vapour of boiling Water. The air receives alſo an infinity of effluvia from fires, mineral works, putrefactions, and other natural or artificial reſolutions of bodies. Hence the atmoſ- Carries off fixt bodies in its exhalation.

WATER. atmoſpherical Waters, though purer than the ſubterraneous, are by no means perfectly pure or elementary.

Atmoſpherical waters. The atmoſpherical Waters are obſerved to be more fertilizing to the earth than any others. Collected with due precaution, and preſerved from any foreign taint, they do not putrefy; though the Rain-waters caught in towns, in ciſterns, in gutters of houſes, ſoon corrupt. To obtain rain, Snow or Hail-water in their greateſt natural purity, they ſhould be collected in clean glaſs veſſels, in an open field, at a diſtance from towns or houſes, at a time when the air is pure, not when the Rain or Snow begin, nor till a conſiderable quantity has fallen, that the lower air may be firſt waſhed from ſuch heterogeneous matters as may have floated in it. Dew, collected on clean linen clothes ſtretched, in clear Weather, at ſome diſtance above the graſs, appears to be one of the pureſt of the natural Waters; though Boerhaave makes Hail-water the pureſt, and next to it that of Snow; accounting dew to be the moſt impure of all, to be a chaos of different exhalations from the earth: Such indeed it may be, when gathered immediately from plants, but not when obtained with the precautions above-mentioned. The dews of May, and the rains of March, are held to be the pureſt; and the rains which fall in ſummer to be the leaſt pure, the air being in this ſeaſon commonly loaded with animalcula or their eggs. The rains which accompany thunder appear to receive no peculiar quality from that circumſtance: The æthereal vivifying ſpirit, which ſome have ſuppoſed them impregnated with, is merely imaginary.

Common waters. The Waters found in the earth or upon its ſurface are divided into ſweet and mineral; the firſt including thoſe which are perfectly inſipid and anſwer for the common purpoſes of life; the other, thoſe which have a manifeſt taſte, and are impregnated with ſaline or other mineral matters. Of the ſweet Waters, that of ſprings, when truly ſweet, is the pureſt. The beſt Spring-water is that which runs through open, hilly, rocky, ſandy, gravelly countries: The Waters which iſſue from black mould, in low and ſhady grounds, is greatly inferior. Spring-water is divided into four kinds: *Aqua ſcaturiens* or *viva*, ſuch as bubbles up naturally at the ſurface of the earth: *Aqua fontana*, ſuch as is lodged deeper, and which, when diſcovered by digging, is encloſed and raiſed by a pump: *Aqua putealis*, Spring-water uninclоſed, or in open wells or ciſterns: *Aqua ſaliens*, Spring-water conveyed by pipes. All theſe Waters are at bottom the ſame, and differ only in being more or leſs ſubject to accidental impurities after their diſcharge from the ſpring. Not to mention the duſt, animals, *&c.* which open wells are liable to receive; even the Waters conveyed by pipes may corrode ſome of the matter of the pipe or its cement, and thus contract diſagreeable qualities. I have examined the aqueducts at Rome, thoſe between Marly and Verſailles in France, and thoſe by which London is ſupplied with the New-river Water; and found them to be in ſome places liable to this inconvenience.

Spring-water.

River-water. River-waters are generally ſuppoſed to be purer than thoſe of ſprings, but I cannot agree in this opinion. All Rivers proceed originally from ſprings, and ſurely they are more liable to gain than to loſe impurities in their courſe. What an immenſity of filth do rivers receive from populous towns and manufactures?

factures? and even in places remote from towns what variety of light vege- WATER.
table and earthy matters is blown into them by every wind? (*a*) The ſmaller, navigable, unfrequented Rivers, in ſtony or rocky countries, between hills, full of ſtones, of a rapid courſe, are generally the cleareſt and pureſt.

The ſtagnant Waters of lakes, ponds, marſhes, pits, ditches, are the moſt impure of all: As they are open, they are ſubject to extraneous impurities; and as they are ſtagnant, they are diſpoſed to putrify. The ſmaller the body of Water, the more it is liable to putrefaction. Pond-waters.

Mineral Waters may be divided into ſaline, bituminous, and noxious. The ſaline Waters are of three kinds, thoſe impregnated with common Salt, the Waters called medicinal, and thoſe whoſe impregnation is too inconſiderable to recommend them to the notice of the phyſician. There are two natural ſolutions of common Salt; Sea-water, and that of ſaline ſprings or brine-pits. The laſt are commonly not only richer in Salt, but more pure ſolutions of it than the firſt. Mineral-waters.

Sea-water is naturally clear and colourleſs as common Water; though it ſometimes exhibits greeniſh, yelloviſh, bluiſh, reddiſh, browniſh, blackiſh, and Sea-water.

(*a*) *Spring and River-waters.*] River-waters, though they ſhould ſeem, from the conſiderations above-mentioned, to be far leſs pure than thoſe of ſprings, are nevertheleſs found, from daily experience, to be the pureſt of the two, or at leaſt to be the beſt adapted to the common purpoſes of life. Spring-waters are very often *hard*, do not boil peas tender, or form a ſmooth lather with ſope, or anſwer for dying, bleaching, waſhing, *&c.* whilſt thoſe of rivers are in general *ſoft*, and fit for all theſe uſes, almoſt equally with Rain-water.

The hardneſs of Spring-waters has been generally aſcribed to their being impregnated with Sea-ſalt. Dr. Home has ſhewn, in his ingenious eſſay on bleaching, that neither pure Sea-ſalt, nor any of the perfectly neutral Salts, compoſed of an acid and an alcali, give any hardneſs to Water: That the common ſorts of Sea-ſalt make Water hard, by virtue only of the heterogeneous Salt which they retain from the bittern (ſee page 211.) That all acids, and Salts compoſed of an acid and an earthy or metallic ſubſtance, have this effect: And that the offending ingredient in hard Spring-waters is a combination of an acid and earth. Sope is a compoſition of Oil and alcaline Salt: On mixing this compound with ſuch a Water, its alcali is abſorbed by the acid of the Water, upon which its oil, deprived of the ſubſtance that made it miſcible with aqueous liquors, ſeparates and curdles on the ſurface: At the ſame time, the earth of the Water, now forſaken by the acid that held it diſſolved, ſettles to the bottom. It follows from this theory, that alcaline Salts in their pure ſtate will diſcover hardneſs in Waters more effectually than ſope, by turning the Water milky or cloudy, and precipitating its earth.

It follows alſo, that by thus precipitating the earth, and neutralizing the acid, they will ſoften the Water; and on trial, they are actually found to produce this deſirable effect: If a ſolution of any fixed alcaline Salt is dropt in by degrees, ſo long as any cloudineſs enſues, and the liquor ſuffered to ſettle till it becomes clear; how hard ſoever the Water was before, it is now found to be ſoft, and fit for all the purpoſes of life .... The ſame gentleman obſerves, that hard Waters are indiſpoſed to corrupt, and even preſerve putreſcible ſubſtances for a conſiderable time: Whence they ſhould ſeem the beſt fitted for ſea, eſpecially as they may be at all times ſo eaſily ſoftened. It has been ſuppoſed, that theſe Waters become purer by boiling: But though, in proportion to the evaporation of the fluid, a part of the earth ſeparates and incruſtates on the ſides of the veſſel, the remaining liquor is found to be harder than at firſt.

WATER. and other colours, from accidental admixtures, or agitations of the Water by ſtorms, or different reflexions of the ſun's rays. The ſuperficial parts of the Water are lighter, leſs ſaline, and more coloured than the lower: While twelve ounces of the ſuperficial Water yielded three drams of Salt, the ſame quantity, taken up from a conſiderable depth, has afforded fifteen grains more. The taſte of Sea-water is not only ſaline, from the common Salt, but manifeſtly bitter.

Bitterneſs of Sea-water ſuppoſed owing to Bitumen.

Count Marſigli endeavours to prove, that Sea-water contains a bituminous matter, from which its bitterneſs proceeds. He obſerves that pure common Salt being diſſolved in Water in the proportion above-mentioned, namely three drams to twelve ounces, with the addition of a ſcruple of Spirit of Pit-coal, the liquor was found to have the bitter as well as the ſaline taſte of Sea-water: That a part of the bituminous matter ariſes with the Water in diſtillation, and incruſtates on the ſides of the glaſs in which the diſtilled Water is long kept: That a pound of Sea-water diſſolved two drams and fifteen grains of Salt beſides what it naturally contained; and that common Water diſſolved more than the Sea-water could be impregnated with.

Owing wholly to bitter Salt.

From theſe and other experiments it is probable, that Sea-water contains a portion of a bituminous ſubſtance, but not that the bitterneſs depends on this ingredient. There are ſundry neutral Salts, as vitriolated Tartar, the *Sal mirabile* of Glauber, the Salts of the purging mineral Waters, which have a very conſiderable bitterneſs, though they contain nothing bituminous; and does not a Salt of this kind actually exiſt in Sea-water? (See page 211.)

It may be proper to obſerve, that Sea-water contains often a nitrous matter; the acid ſpirit diſtilled from Sea-ſalt proving a menſtruum for Gold, which the marine acid by itſelf never does, and which nothing but the nitrous will enable it to do. Though this however is frequently the caſe, it is not always: I have examined marine Salt, whoſe acid had no action on Gold.

Methods of ſweetening Sea-water.

Different methods have been contrived for ſweetening Sea-water, or freeing it from the Salt, ſo as to render it fit for drinking and for the common uſes of life. Some have endeavoured to ſeparate the Salt in the way of precipitation; but all the known ſubſtances, that are capable of throwing down any of the Salt, are in part retained themſelves by the Water, ſo as to communicate to it diſagreeable or dangerous qualities. Others have propoſed filtration through porous ſtones, ſands, and inſipid earths: It appears from experience, that Water, in paſſing through a conſiderable thickneſs of theſe kinds of ſubſtances, will leave great part of its Salt behind, and by repetitions of the filtration, nearly the whole: But the quantity of ſtony or earthy matter requiſite for this purpoſe is much too large, and the proceſs itſelf too tedious, to have place on board a ſhip, where ſuch expedients are principally wanted. Becher mentions a certain pump, contrived by one Walker in England, by means of which freſh Water might at once be pumped up from the Sea: This inſtrument was not only found too expenſive, but wanted durability, and could not be worked on board a ſhip. The beſt method is diſtillation: The only objections to this are, that diſtilled Sea-water does not quench thirſt like common ſweet water, and that the proceſs is too expenſive and incommodious to be practiſed at ſea. The firſt may be eaſily remedied by certain additions,

that

that ſhall abſorb the looſe acid in the Water, and prevent its ariſing: With regard to the other, diſtilling veſſels have been contrived, in which the proceſs may be continued without intermiſſion, in all kinds of weather, notwithſtanding the motions of the ſhip, with little fuel, and at little expence (*b*). I ſaw, in the French academy, a drawing of a curious machine of this kind invented by M. Gautier, of which there is ſome account in the Breſlau collections for the years 1717 and 1718. It were greatly to be wiſhed that this proceſs could be introduced into general practice, ſo as to relieve the diſtreſſes to which ſailors are ſo often expoſed, from their Water either failing, or putrefying and breeding worms. Boerhaave informs us, that the Dutch Eaſt India ſhips uſe a ſaline mixture for preſerving their Water ſweet, compoſed of twelve parts of Aqua fortis or Spirit of Nitre, ten parts of clean Rheniſh Tartar, and two parts of purified Saltpetre: Theſe ingredients are put into a glaſs body, and digeſted in the heat of a Water-bath till the Salts are diſſolved, after which the liquor is ſtrained and ſet by to ſettle. The Water, to be taken in is boiled, an ounce of this ſaline liquor added to every eighty pounds, the boiling continued a little longer, and the Water, when grown cold, filled into caſks.

WATER. Preſervation of Water from corruption.

The ſecond ſort of Waters impregnated with Sea-ſalt is the Brine-water or that of ſaline ſprings: From this, the pureſt common Salt is uſually extracted. The quantity of Salt is different in different ſprings; ſome holding no leſs than three ounces and three drams upon a pound, and ſome few ſtill more; whilſt others contain leſs than Sea-water does, ſome ſcarce two drams on a pound. Theſe Waters are for the moſt part a pure brine of common Salt, though ſome of them have alſo an aluminous impregnation (*c*).

Brine-ſprings.

(*b*) *Sweetening of Sea-water.*] This proceſs has of late received notable improvements from the happy induſtry of Dr. Hales. He finds, that the addition of a ſmall proportion of chalk ſerves to prevent any acid from ariſing, and thus renders the diſtilled liquor perfectly ſweet: And that by driving a ſtream of air through the Water in the ſtill, the quantity drawn off proves at leaſt double to what would ariſe in an equal time without that aſſiſtance. By this method, he obſerves, a ſtill which holds twenty gallons will yield, in twenty hours, two hundred and forty gallons of freſh Water, with little more than two buſhels of coals. A ſmall ſtill, of five gallons, produces ſixty-four gallons in twenty hours. The ſtill may be occaſionally ſupplied with Sea-water by a cock in the head, without loſs of time in unluting it; and that all poſſible advantage may be gained, the Water warmed in the worm tub may be employed for this purpoſe.

It is ſaid, that the diſtillation is ſtill further expedited, by dividing the head of the ſtill into a number of partitions, by parallel plates. There is doubtleſs conſiderable room for improvement in the ſtructure of ſtills; but the particular advantage of this conſtruction I do not apprehend. The largeneſs of the ſurface expoſed to the air, or to any other medium leſs hot than the included vapour, will undoubtedly promote its condenſation; but plates within the ſtill-head muſt ſoon become equally heated with the vapour itſelf: Perhaps, widening the paſſage of the vapour would anſwer better: It is certain that the evaporation of liquids, by an equal heat, is in proportion to the ſurface of the liquor itſelf, and to the freedom of the vapours paſſing off; and that in the common ſtill, the vapour is ſo much obſtructed, as when the heat is raiſed too high, to blow off the head.

(*c*) *Brine-ſprings —— Aluminous impregnation.*] It may be doubted whether any of theſe Springs contain a true Alum. Many

WATER. Medicinal-waters.

The Medicinal Waters to which alone cuſtom has erroneouſly appropriated the name of Mineral, are impregnated either with vitriolic acid, with the alcaline baſis of Sea-ſalt, with a ferrugineous earth diſſolved by the vitriolic acid, or a certain alcaline earth combined with the ſame acid into a bitter purging Salt ſimilar to the *Sal mirabile*. Theſe Waters are commonly divided into *Acidulæ* and *Thermæ*; the firſt comprehending, not really acid waters as the name imports, but all thoſe which are cold; the latter, the hot ones, ſome of which are of a quite ſcalding heat. The hot Waters commonly contain more of a groſs earthy matter, imperfectly diſſolved, than the cold; as appears from the hard ſtony ſubſtance, uſually of a yellowiſh or reddiſh colour, with which the channels of the former are from time to time plentifully incruſtated. The methods of examining the contents of particular mineral Waters may be ſeen in Hoffmann's writings *De acidulis & thermis*, Seip's treatiſe of Pyrmont Water, ſome papers in the French memoirs, *&c.* The principal trials are, 1. Evaporation; by which we not only diſcover the quantity of ſolid matter contained in the Water; but at the ſame time, as we here obtain that matter by itſelf, are enabled to determine what it is: By elixating it with pure Water, we obtain the ſaline and the indiſſoluble parts ſeparate from one another. 2. Diſtillation; by which we are enabled to diſcover whether the Water contains any volatile matter, ſaline or bituminous. 3. The admixture of certain liquors; as Syrup of Violets, infuſion of galls, ſolutions of Lead and Silver. Theſe and other liquors exhibit different phænomena according to the ſubſtances which the Water is impregnated with: Thus Syrup of Violets is changed red by acids, and green by alcalies; infuſion of galls ſtrikes a black colour with ferrugineous ſolutions, and with theſe only; ſolutions of Lead and Silver, dropt into liquors participating of Sea-ſalt or vitriolic acid, render them cloudy or turbid, and depoſite their metal combined with thoſe ſaline bodies (*d*)——Moſt of the Medicinal-waters undergo an alteration in their compo-

of them participate of the bitter purging Salt, which has not unfrequently been miſtaken for Alum, and which in ſome reſpects greatly reſembles it; both Salts bubling up in the fire, and turning into a light ſpongy unfuſible calx; and both being compoſed of the vitriolic acid combined with an earth: They differ however in many eſſential properties, the earth in one being of a diſtinct kind from that of the other.

(*d*) *Examination of Mineral-waters.*] The art of inveſtigating the contents of Mineral-waters has been encumbered with a multiplicity of experiments more oſtentatious than uſeful. The phænomena reſulting from the admixture of other bodies with the Water are for the moſt part fallacious; Waters very diſſimilar in quality exhibiting, on theſe kinds of trials, ſimilar appearances. The principal additions made uſe of in this view, and the changes enſuing upon their mixture with different Waters, are as follows.

Syrup of Violets is changed red by Waters impregnated with a pure acid, or with Alum; and green by ſuch as contain a prevailing alcali, a combination of calcareous earth with marine acid, and ſome other compound Salts both earthy and metallic.. *Alcalies* effervеſce with acid Waters, and with ſome of thoſe which contain Salts compoſed of an acid with an earth or metal.. *Fixed alcaline Salts* produce a cloudineſs or milkineſs in Waters impregnated with Alum, with the purging bitter Salt, with the Salt called fixed Sal ammoniac, and in general with any combination of acid and earth: They likewiſe render all metallic

compoſition, and loſe of their virtue, on being carried to any conſiderable diſtance, or long kept; though taken up and ſecured with the greateſt precautions,

metallic ſolutions turbid, and precipitate the metal from theſe, as the earth from the others . . *Volatile alcaline Salts* or Spirits have the ſame general effects as the fixt; with this particularity, that they ſtrike a blue colour with ſolutions of Copper: Hence volatile alcalies are of good uſe for diſcovering Copper; and *ſolutions of Copper*, for diſcovering volatile alcalies . . *Sope* is curdled by acid Waters, and by all thoſe which are made turbid by alcalies . . *Solution of Sope* in vinous ſpirits is rendered milky by the ſame Waters . . With all thoſe Waters alſo, a *ſolution of Sulphur* in alcalies or Lime-water, becomes milky, and emits a ſtrong fetid ſmell . . *Acids* effervеſce with Waters in which an alcali or earth prevail; and turn all thoſe liquors milky which contain ſubſtances diſſolved by alcalies . . *A ſolution of Silver* in Aqua fortis produces a milkineſs in all that contain an alcaline Salt, Sea-ſalt, fixed Sal ammoniac, bitter purging Salt, Alum, Sal mirabile, or other combinations of the marine or vitriolic acids with alcalies or earths . . *Solution of Mercury* makes all thoſe Waters turbid that ſolution of Silver does . . And *ſolution of Lead*, the ſame . . . Upon the whole, experiments of this kind may ſerve to inform us, that certain Waters participate of ſome mineral impregnation, but not to determine what that particular ſubſtance is. I can recollect but two inſtances, in which ſimple mixture affords any degree of certainty; the blue colour from Copper and volatile alcali, and the bluiſh or purple from Iron and ſome aſtringents.

The ſimple and obvious method of analyſing Waters, is, to gently diſtil a large quantity in clean glaſs veſſels, and examine the diſtilled liquor and reſiduum ſeparately. 1. The diſtilled liquor is ſometimes found to turn Syrup of Violets red. We may be ſure that this effect proceeds now from a pure acid, and not from a combination of an acid with any other body. 2. The reſiduum conſiſts of a ſaline part ſoluble in pure Water, and an earthy one. By careful cryſtallization, the Salts may be ſeparated from one another, and obtained in their proper form; or they may now be diſcovered with certainty, by means of additions, without ſuch ſeparation.

A prevailing unſaturated alcali is eaſily known, by its raiſing an effervеſcence with the marine and with vegetable acids. The fixed matter may effervеſce with the ſtronger acids, and turn Syrup of Violets green, though it contains no alcali.

The other Salts are compoſed of an alcali or earth ſaturated with one or more of the mineral acids . . 1. The baſis or ſubſtance combined with the acid, is found, by adding, to the ſaline ſolution, a ſolution of any pure alcaline Salt. If the baſis is an alcali, no change will enſue from the admixture of its like; but if an earth, it will be precipitated. Spirit of Vitriol, added to the earth, will readily diſcover of what kind it is; this acid diſſolving the aluminous earth into an highly aſtringent liquor, magneſia into a bitter one; and not at all, or not perfectly diſſolving the calcareous. For the greater certainty in regard to this laſt, we may diſſolve the earth in ſome other acid, as Aqua fortis, and then add ſome Spirit of Vitriol, which will precipitate the calcareous earth, and leave both the other earths diſſolved. 2. The ſpecies of acid may be diſtinguiſhed by adding to the dry compound a little ſtrong Spirit or Oil of Vitriol: If the acid is the marine, it will be inſtantly expelled in white, and if the nitrous in red fumes; but if it is the vitriolic, no change will enſue. The marine acid may alſo be known, by the matter enabling Aqua fortis to diſſolve gold; the nitrous, by its fulminating, when ignited, on the contact of any inflammable matter; the vitriolic, by its precipitating any ſolution of calcareous earth, as of Chalk in Spirit of Salt or Aqua fortis. Alcaline Salts alſo precipitate ſuch a ſolution, but with this difference; that when the liquor has grown milky, a little freſh Spirit of Salt or Aqua fortis will render it clear again if the effect proceeded from an alcali, but make no change if from the vitriolic acid: The precipitate thrown down by the former is a calcareous earth again, by the latter a ſelenites.

WATER. tions, and preſerved in cool cellars. Where theſe medicines therefore are had recourſe to, the patient is always to be adviſed to the Spring itſelf: Here, beſides enjoying the Water in its perfect ſtate, exerciſe, change of air, amuſements, company, freedom from domeſtic cares, will greatly aſſiſt its ſalutary virtue.

Bituminous Waters. Bituminous Waters are thoſe which have a mineral oil or bitumen either floating diſtinct on the ſurface, or intimately diſſolved in ſmaller quantity. There are ſundry Waters which abound with bituminous matter, as near Bologna, in Neuchatel, in the electorate of Hanover and other places. If we ſeparate from theſe Waters all the bitumen that appears undiſſolved, the Water is ſtill far from being pure: It permanently retains a ſtrong bituminous ſmell and taſte.

Noxious Waters. The noxious Waters are of three kinds, 1. The petrifying Waters, or ſuch as abound with earthy or ſtony matter, which incruſtates on ſolid bodies kept in the Water, and often ſpontaneouſly ſeparates, eſpecially on the exhalation of a part of the fluid; whence the *ſtalactitæ*, ſtony icicles, dropſtones, often met with in caverns of the earth. Some of theſe Waters depoſite their contents in a powdery form; others in that of a crumbly, and others of a very hard ſtony maſs. 2. The vitriolic, cupreous Waters, or thoſe impregnated either with a pure vitriol of Copper, or a mixt vitriol of Copper and Iron. 3. The directly poiſonous Waters, as the arſenical ones found in mines. A Water may be prepared by the chemical art, which though nearly inſipid, ſhall be highly poiſonous: But as this might be abuſed to pernicious purpoſes, I forbear to mention its compoſition.

Properties of pure Water: We have hitherto given a general view of Waters, as naturally blended with other ſubſtances: We ſhall now conſider the principal properties of the purer kinds of ſweet Water.

its ſpecific gravity; This fluid is inſipid, inodorous, colourleſs, tranſparent. Its gravity is to that of Gold nearly as one to twenty: Eiſenſchmid, in his diſſertation *De ponderibus & menſuris veterum, &c.* gives an account of the abſolute weight of different ſorts of Water, in winter and in ſummer: He obſerves, that a cubic inch of Spring-water, taken in ſummer, weighs five drams eleven grains, in winter five drams fourteen grains; the ſame volume of River-water, in ſummer, five drams ten grains, in winter five drams thirteen grains; diſtilled Water in ſummer five drams eight grains, in winter five drams eleven grains; Sea-water in ſummer ſix drams twelve grains, in winter ſix drams eighteen grains.

ſubtility; Water is an extremely ſubtile fluid, capable of pervading not only the minuteſt veſſels of animals and vegetables, but by means of preſſure, the ſolid bodies of metals, even the moſt ſolid and compact of all metals, Gold itſelf.

incompreſſibility; This appears from an experiment made by the gentlemen of the Florentine academy: A hollow golden ball being filled with Water, the aperture cloſely ſecured, and the ball ſtrongly preſſed, the Water oozed out in little drops all

poroſity; over the ſurface of the metal; a proof both of the poroſity of Gold, and of the ſubtility and incompreſſibility of Water. That this fluid nevertheleſs contains pores, or vacuities between its particles, is evident from its diſſolving a conſiderable quantity of ſeveral kinds of Salts, without any ſenſible increaſe of its volume.

In

In a certain degree of cold, this fluid is converted into a ſolid, hard, tranſparent, elaſtic maſs, capable of being poliſhed like glaſs, and, when reduced to the ſame figure, producing the ſame effects as the magnifying and burning-glaſſes. We may properly, with Boerhaave, look upon ice as the natural ſtate of Water; and its fluidity to proceed from external warmth, not as that author alledges from particles of fire intermixed. If particles of fire confined in bodies were the cauſe of fluidity, quickſilver would neceſſarily contain more fire than Water does, as being more fluid, and more permanently ſo; and yet Boerhaave himſelf admits that quickſilver is far colder than Water. WATER. congelation;

In a ſmall degree of heat, it exhales ſucceſſively in vapours, which caught in diſtilling veſſels condenſe into water again, unchanged in its quality. The action of air and wind remarkably promote its evaporation, the air imbibing and carrying off the watery particles——When made to boil, it is found to have received the greateſt heat which it is ſuſceptible of: How ſtrongly ſoever the fire be raiſed after this period, the water will grow no hotter, provided the veſſel is open: Hence we are furniſhed with one equal ſtandard degree of heat for the graduation of thermometers (*e*); and the freezing of water affords another. It is obſervable, that if a phial or other veſſel of Water, however thin the glaſs, be kept in boiling Water, the Water in the phial will not boil—In cloſe veſſels where the vapour is perfectly confined, Water may be heated to a conſiderably greater degree than it will receive in open ones, and by this means its activity on certain bodies, or its power of diſſolving them, may be greatly increaſed: Hence Papin's digeſtor. But this confinement of the vapour is accompanied with great danger to the byſtanders, the vapour of Water when ſtrongly heated, being extremely elaſtic, ſo as to burſt even an Iron bomb-ſhell with violent exploſion. The extraordinary expanſive power of the ſteam of boiling Water is applied to valuable purpoſes in ſome machines, as particularly in the fire engine. exhalation; ebullition; heated beyond ebullition; elaſtic vapour;

Water added to burning Wax, Pitch, Reſin, Oil, Fat, or other like ſubſtances, increaſes the flame. Without water there can be no flame, this fluid being the very baſis of the flame: When Coals, Wood, *&c.* are freed from all humidity, or reduced to a coal, they flame no longer. Not that Water contains in itſelf any thing truly inflammable, or that can ſerve as a pabulum of fire; but from its expanſive vapour proving a vehicle to the inflammable matter of the fuel, and carrying it up in an ignited ſtate. Hence it is obſerved, that in conflagrations, the throwing on of a little Water increaſes the fire. augments flame;

Conſiderable degrees of heat and cold are producible in Water, by the bare admixture of certain other bodies. By diſſolving in it ſome ſaline ſubſtances, particularly Sal ammoniac and Mercury ſublimate, it becomes notably colder: On the other hand, if Oil of Vitriol be haſtily poured into cold Water, the mixture becomes inſtantly ſo hot, that the glaſs cannot be held in the hand. made hot and cold by mixture.

Water diſſolves all Salts, tho' not all with equal facility, or in equal quantity. It diſſolves moſt eaſily the powder Sugars, and fixed alcalies; next to theſe, ſome of the neutral Salts, as the Sal diureticus, ſoluble Tartar, Sal mirabile, common As a menſtruum for Salts.

(*e*) *Boiling heat.*] Later experiments have ſhewn, that the heat of boiling Water varies according to the purity of the Water itſelf, and the gravity of the atmoſphere.

WATER. mon Salt, Sal ammoniac, &c. More difficultly, Nitre, Alum, Sugar of milk; moſt difficultly of all, Borax, Tartar, vitriolated Tartar, Salt of Sorrel. Its action is in general greatly promoted by heat and by agitation: By means of theſe it may be made to take up a larger quantity of moſt kinds of Salts than it is capable of keeping diſſolved when thoſe cauſes are removed: Thus if boiling Water be ſaturated with as much Salt as it will in that ſtate diſſolve, a part of the Salt will ſeparate as the liquor cools. Boerhaave alledges that Water will not diſſolve any Salt without heat: This is a mere play upon words, for by Water he means Ice——When Water is overloaded with Salts by means of heat, the part of the Salt which ſeparates on cooling generally concretes into ſolid maſſes, tranſparent, and of regular figures, and hence called by the chemiſts *Cryſtals*, as having ſome reſemblance in appearance to the ſtones of that name. The author above-mentioned makes cold neceſſary to the cryſtallization of Salts: In this he is miſtaken; for many Salts ſhoot into more perfect cryſtals, if the ſolution is kept in a gentle warmth that the Water may ſlowly exhale, than if it is removed into a cold place: The Cryſtals of Sugar called Sugar Candy, are always prepared in a hot room, and the ſame proceſs is applicable to ſundry other Salts. There are therefore two diſtinct principles of cryſtallization: the one, a conſtant ſucceſſive exhalation of the Water by heat; the other, a diminution by cold, of that power in the Water by which it held the Salt diſſolved.

Cryſtallization of Salts;

quantity of different Salts which it diſſolves;

Several chemiſts have given us experiments of the quantity of particular Salts ſoluble in a certain quantity of Water. Theſe experiments agree but ill with one another: One ſays, a pound of Water diſſolves two ounces of Saltpetre, another only ſix drams: One, that a pound diſſolved an ounce of *Arcanum duplicatum*, another as much again: One, that a pound of Water would take up no more than ſix drams of green Vitriol, another that it diſſolved four ounces and more: One, that Water will diſſolve equal its own weight of Epſom Salt; and another that it will not diſſolve half its weight: And the caſe is the ſame in other Salts. I therefore made ſundry experiments of this kind myſelf, and found that one ounce of Water diſſolved two ounces of white powder Sugar, two ounces of brown powder Sugar, nine drams of white Sugar Candy, nine drams of brown Sugar Candy, nine drams of Canary Sugar, one ounce of white Sal diureticus, one ounce of black Sal diureticus, one ounce of Epſom Salt, ſix drams of Sedlitz Salt, ſix drams of pure fixed alcaline Salt, half an ounce of white Vitriol, half an ounce of Goſlarian Vitriol, half an ounce of Vitriol of Iron, three drams and one ſcruple of Sal gem, three drams of common Spring-ſalt, three drams of Sea-ſalt, two drams of Sal mirabile, two drams of volatile Salt of Sal ammoniac, two drams of crude Sal ammoniac, two drams of Pot-aſh, two drams of Cyprus Vitriol, one dram and ten grains of purified Nitre, one dram of antimoniated Nitre, one dram of Sal prunell, one dram of ſoluble Tartar, one dram of the Sal embryonatum, one dram of the Salt of the Carlſbade baths, two ſcruples and a half of crude Alum, two ſcruples of Sal polychreſt, two ſcruples of the Salt of the Egra waters, half a dram of *Arcanum duplicatum*, half a dram of vitriolated Tartar, one ſcruple of Sugar of Milk, one ſcruple of Sugar of Lead, one ſcruple of emetic Tartar,

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fifteen grains of Borax, ten grains of Salt of Sorrel, five grains of white Tartar, five grains of cryſtals of Tartar. WATER.

Super-impregnation of Water with Salts.

It is obſervable, that Water, when ſaturated with one Salt, will ſtill diſſolve a conſiderable portion of another; when ſaturated with this, it will ſtill take up a third, and thus ſucceſſively different ſorts, till ſix, ſeven or more are taken up by the ſame Water. Thus four ounces of Water diſſolve only a dram and a few grains of Alum, and will not touch any more of that Salt; but the ſame Water will diſſolve five drams of Salt-petre, after this half an ounce of green Vitriol, then ſix drams of common Salt, three drams of ſoluble Tartar, and five drams of Sugar: It will ſtill take up an ounce of fixed alcaline Salt, though a precipitation now begins, as always happens upon the commixture of alcalies with aluminous and vitriolic ſolutions. In like manner four ounces of Water, ſaturated with half an ounce of Salt-petre, will diſſolve half an ounce of white Vitriol, ſix drams of common Salt, ſix drams of Sal ammoniac, half an ounce of ſoluble Tartar, and after all theſe, a whole ounce of Sugar.

Precipitates ſome metallic ſolutions;

Boerhaave obſerves, that there are ſome metallic Salts which Water will not diſſolve, as the thick fluid called Butter of Antimony. Butter of Antimony is a ſolution of regulus of Antimony in marine acid; which acid does not diſſolve that ſemi-metal unleſs the acid is highly concentrated, and, after it has diſſolved it, lets it fall again on being diluted with Water. If he had ſaid, that ſome metallic bodies will not diſſolve in diluted acids, and that when diſſolved in concentrated ones they are precipitated upon diluting the liquor with Water, as Reſins are precipitated from Spirit of Wine; the obſervation had been juſt.

as a menſtruum for vegetable and animal ſubſtances;

Water diſſolves vegetable gums and mucilages, as Gum arabic, cherry-tree gum, &c. and extracts the gummy parts of concrete or inſpiſſated vegetable juices, as Myrrh, Ammoniacum; or of entire vegetable matters, as Marſh-mallow roots, Quince-ſeeds, &c. It likewiſe readily diſſolves and extracts the gelatinous or glutinous parts of animals; hence ſoups, gellies, glues: Bones themſelves are ſoftened, and all but their earth diſſolved by it, in Papin's digeſtor. Cold and hot Water produce very different effects on ſome animal matters: The whites of eggs diſſolve or mingle with the former, but are coagulated by the latter and rendered indiſſoluble: Some other animal matters alſo are rather hardened, than ſoftened or diſſolved, by boiling Water.

its action on oils, varniſhes, &c.

Water does not diſſolve or unite with earths, ſtones, metals, ſulphur, bitumens, nor any mineral body that is not manifeſtly ſaline; nor vegetable oils or Reſins, or animal fats—It extracts however ſome of the finer parts of the eſſential oils of vegetables, ſo as to become impregnated with their flavour: Hence the ſmell and taſte of diſtilled Waters. Oily and reſinous varniſhes, and oil-paintings, if a little warm Water is ſuffered to lye upon them for ſome time, or if long expoſed to the weather, loſe their luſtre, and are at laſt deſtroyed. The Prince of Heſſe had the roof of his orangery painted at great expence by Dagly, after ſeeing, as a proof of the goodneſs of his varniſh, Water boiled over a coal-fire in a veſſel of varniſhed paper: The varniſh however, which ſtood this teſt, was deſtroyed by the weather in a few years.

WATER. On Metals,

Cold Water corrodes alſo ſome metallic bodies, Copper, Iron, Braſs, Lead, Tin; as we ſee in the pipes and cocks of water-works, and in ſundry water-machines. It is obſervable, that Iron and Sulphur, on each of which, ſeparately, Water has no conſiderable action, if mixed together and moiſtened with Water into the conſiſtence of pap, grow hot, and even burſt into actual flame. This fluid extracts ſo much from the Regulus and from the glaſs of Antimony, as to become emetic: By ſtanding for a night in a copper veſſel, without heat, it contracts a diſagreeable cupreous taſte. Iron, heated red and quenched in Water, communicates a manifeſt taſte, eſpecially if the extinction is ſeveral times repeated; and Quickſilver boiled in Water is ſaid to impregnate the liquor with the anthelmintic and other virtues of that mineral. Langelot, by grinding Gold for a length of time, in a particular mill, reduced the metal to ſuch a degree of tenuity as to remain ſuſpended in Water.

and Stones.

Stones alſo in certain circumſtances are ſubject to the action of this fluid. How often do we meet with Stones excavated by the dripping of Rain? how ſmooth are they made in rivers by the attrition of the Water? how crumbly do the hardeſt Stones become, by repeated ignition and extinction in Water? All the Stones and Earths which burn into Quicklime, are, in that ſtate, in great part diſſolved by ſimple Water.

By the mediation of other ſubſtances diſſolves all bodies.

The bodies which are not acted on by pure Water, are all diſſoluble in it by the mediation of other ſubſtances; particularly of alcalies or acids. In this light, Water may be called an univerſal menſtruum; and it is the only menſtruum which can deſerve that name. Glaſs, Earths, the hard Stones, Flint, Cryſtal, *&c.* melted with ſeveral times their own weight of fixed alcaline Salt, diſſolve readily in Water along with the alcali, and may be diluted to any degree. Sulphur alſo is made ſoluble by fixed alcalies; and all metallic bodies by the compoſition of Sulphur and alcali, or by acids. Water impregnated with fixt alcali, eſpecially if the alcali is rendered cauſtic by Quick-lime, diſſolves Hair, Feathers, Wool, vegetable Reſins; and reduces oils and fats into Sope. Sundry Oils, Reſins, Balſams are likewiſe rendered miſcible with Water, by yolk of eggs, Sugar, Almonds, and other ſubſtances. The moſt intimate combination of oil with Water is that effected by fermentation: By this proceſs they are united into one apparently homogene fluid, an inflammable ſpirit——Water and this ſpirit mingle readily together: But if either of them is previouſly combined with certain other bodies, they either will not unite at all, or not without letting go the ſubſtance which they held before in ſolution. Thus if Water be impregnated with fixed alcaline Salt, inflammable ſpirits, however ſhaken with the ſolution, will not mingle with it, but float diſtinct upon the ſurface. On the other hand, if certain neutral Salts be diſſolved in the Water, the Water will readily mingle with inflammable ſpirits, and throw off the Salt, whence the uſe of vinous ſpirits in promoting the cryſtallization of Salts: And in like manner if reſinous bodies are diſſolved in ſpirit, the ſpirit will let the Reſin go, and unite with Water.

Earth left in diſtillation.

The pureſt of the common Waters leave in diſtillation a conſiderable portion of earthy matter: If the diſtilled Water be diſtilled over again, it leaves a little more earth, and this ſucceſſively for a great number of times. Boyle relates, that an ounce of Water, cautiouſly diſtilled over, in glaſs veſſels, two hundred

times,

times, yielded ſix drams of a white, light, inſipid earth, fixed in the fire, and indiſſoluble in Water. Newton and others ſuppoſe the Water in theſe experiments to be really converted into earth: Boerhaave ſuſpects the earth thus obtained to be no other than duſt that had been floating in the elaboratory; though I have never obſerved ſuch duſt to be white, like the earth left in the diſtillation of Water. If the Water be evaporated in broad, ſhallow, open veſſels, the reſiduum is much leſs than when diſtilled in cloſe ones. Even the Spring-waters which plentifully incruſtate tea-kettles with a ſtony matter, leave little or no earth on being boiled away with a large ſurface expoſed to the air. WATER. Elevated in evaporation.

The purity of Water is judged, from its limpidity, and want of ſmell and taſte; from its ſparkling or emitting air bubbles on being poured into a glaſs; from its comparative lightneſs; from its depoſiting no ſediment in ſtanding; from its ſoon growing hot, and ſoon becoming cold again, comparatively with other Waters; from its being comparatively warm in winter, and cold in ſummer; from its leaving little or no reſiduum on being evaporated or diſtilled; from its eaſily lathering with ſope, boiling pulſe tender, and bleaching linen white; and from its readily paſſing through the body when drank. To which may be added, that the beſt Waters are thoſe which run through flinty or ſandy grounds, and from eaſt to weſt. Marks of the purity of Water.

Some have endeavoured to correct impure Waters, by boiling, ſuffering them to ſettle, then decanting, and repeating theſe proceſſes ſeveral times: By ſuffering the Water to putrefy, then decanting and putrefying it again: By boiling it with waſhed ſand, and afterwards filtering: By boiling it, and after ſettling, adding a little Spirit of Vitriol: By analyſing the Water ſo as to diſcover the offending matter, and then precipitating that matter by its contraries. This laſt method appears to be the beſt and moſt effectual——With regard to the preſervation of Water, open wooden veſſels ſhould never be employed for that uſe; for in theſe it ſoon corrupts. In glaſs veſſels, well corked down and cemented, good Water will keep for ages. A ſmall addition of Spirit of Vitriol or Spirit of Nitre will preſerve Water from putrefaction: At the time of uſing, the acid may be ſaturated and rendered innocent by a little Salt of Tartar. See page 251. Impure Waters corrected. Preſervation of Waters.

PART II.

CHEMICAL HISTORY

OF THE

VEGETABLE KINGDOM.

SECTION I.

Of VEGETABLES *in general.*

Vegetables. Structure of vegetables.

VEGETABLES are bodies of a regular organic ſtructure, analogous in ſome degree to that of animals. They are furniſhed with a variety of veſſels for receiving, tranſmitting, perſpiring different fluids; with organs, by which, the aliment they imbibe from the earth, from water, or from the air, is changed into new forms, into juices peculiar to particular plants. No art can prepare or extract from the ſubſtances by which vegetables are ſupported, products in any reſpect ſimilar to thoſe elaborated in the bodies of vegetables themſelves. Diſſimilar plants, nouriſhed by one and the ſame ſoil ſtill preſerve their ſpecific differences, not only in their external form, but in their intrinſic qualities.

Differences in quality, from ſoil, climate,

There are, however, very conſiderable differences in the quality of one and the ſame plant, from the ſoil, climate, ſeaſon, and other like circumſtances. The finer aromatic herbs, naturally produced in dry, ſandy grounds, if removed into moiſt rich ones, increaſe in bulk, but loſe greatly of their fragrance,

grance, as if their active principles were exhausted in a luxuriance of growth (*a*). Immoderately rainy seasons occasion a like alteration without change of soil. The intensely bitter Colocynth, a native of Persia, almost entirely loses its bitterness when raised on our hotbeds, and grows to ten, fifteen, twenty times its natural size (*b*). Vegetables.

When

(*a*) *Exhausted in a luxuriancy of growth.*] It is a common observation, that trees which spread luxuriantly into branches, bear little fruit in comparison with those of the same kind which are less exuberant: Hence art, by stunting their growth, increases their fertility, and at the same time improves the quality of the fruit. Mr. du Hamel supposes, with great probability, that the improvements made by grafting proceed wholly from the check given to the increase of the woody part: and hence he infers, that the best bearing trees must be those where the graft is so remote from the nature of the stock, as to be but just supported or kept alive by it.

(*b*) *Spontaneous vegetables.*] A due attention to the circumstances in which particular vegetables are spontaneously produced, leads directly to the sure and successful means of cultivating them by art. Linnæus justly observes (in a curious paper upon this subject in the first volume of the Swedish Acts) that the directions given in many books of gardening are founded in empyricism or random practice; and that it is from mild plants alone that a rational method of culture can be deduced; that all plants grow somewhere wild, and that the business of art is to imitate their natural climate. By climate is understood the joint concurrence of earth, air, water and heat.

The earths or soils in which vegetables grow, are far from being the simple bodies mentioned under that head in the foregoing part: They are compounded of all the kinds of mineral earths, and of that into which animal and vegetable substances themselves are resolved by putrefaction, blended together in various proportions. They may, nevertheless, be commodiously ranged, in regard to the present view, into four classes, according to the particular ingredient which prevails in the composition: (1.) Clayie, (2.) chalky, (3.) sandy, including those which abound either with sand itself, or with such other earthy or stony particles as do not in the least imbibe or are affected by water; and (4.) black vegetable and animal mould. Each of these soils produces plants peculiar to itself, and which degenerate or perish in others. It is on sandy hills that the Fir and other resinous trees attain to their vigour, and shed their Turpentines and Balsams: The *Galeopses*, as the above-mentioned author observes, are the natural growth of black earth, and die in sand, whilst *Ornithopus* flourishes in sand, and perishes in a black mould.

Under air may be included the vicissitudes of solar light diffused throughout the atmosphere; which light seems to affect vegetables independently of heat, and in a manner hitherto inexplicable. All plants grow weak and slender in the confined air of hothouses, and much more so if the solar light is excluded. Plants whose flowers are naturally the most odoriferous, if raised in a perfectly dark place with all the advantages of warmth, moisture, *&c.* either do not flower at all, or bring forth flowers which have hardly any smell. The Jasmine-tree whilst it covers the outside of a wall with its fragrant flowers, is not observed to produce a single one upon such branches as have forced their way within, even into a warm, an airy and a light room. High hills in different parts of the world, the Lapland crags, the Alps, Olympus, and Ararat, bring forth similar plants, many of which are never met with in lower grounds. These plants grow extremely quick, nature making amends for their shortness of summer, by a continual agitation and renewal of air: They are small, but loaded with innumerable seeds. Removed into gardens, they grow more slowly to a larger size, but abort, or produce little fruit.

River, stagnant, spring, and sea-waters, and watery and dry soils, have each their peculiar plants: Succulent plants rot from the quantity of water which many others require.

Vegetables. When mineral Salts abound in the ſoil, they are in part imbibed by the plant, and appear to be unſubduable by its digeſtive powers. Hence vegetables produced in nitrous grounds, or in ſuch as have been largely dunged, are

require. It is obſervable, however, that land as well as aquatic vegetables may be raiſed and ſupported for a length of time, by placing the little roots, waſhed clean from earth, in water alone. It ſeems as if water and air, or the contents of waters and of the atmoſphere, were univerſally the immediate matter which affords aliment to vegetables; as if the earth ſerved only as a matrix for vegetables to keep them firm, and to preſerve moiſture about the roots; as if the difference of ſoils conſiſted wholly in their being more or leſs ſoft or compact, ſo as to be eaſily or difficultly penetrated by the tender roots, and in their more or leſs readily imbibing and effectually retaining water. Thus clay abſorbs water very ſlowly and difficultly, its particles expanding in proportion as they are moiſtened, ſo as to prevent the further progreſs of the liquor: If water be poured into a cavity made in a lump of dry clay, great part of it evaporates without being ſoaked in. Chalk on the other hand very quickly imbibes water, tranſmits it to every part of the maſs, and does not eaſily let it go; whilſt ſand ſuffers it to percolate inſtantaneouſly through the interſtices of the grains, without imbibing any into its ſubſtance.

With regard to heat, the plants of the torrid zone require, according to Linnæus, between the fiftieth and ſixtieth degree of Fahrenheit's thermometer; thoſe of the temperately warm, as the ſouthern parts of Europe, the Cape, Japan, China, between the thirtieth and fortieth; thoſe of the temperately cold, not above thirty-eight. Theſe ſeem to be nearly the mean degrees of heat of the reſpective climates. The plants of cold climates will not bear the heat of warm ones, any more than thoſe of the warm can ſupport the cold: Some of the Cape plants in the heat of the torrid zone, grew at firſt amazingly, but ſoon after they loſt their leaves, and were difficultly kept alive. In this, however, there is a conſiderable latitude: Plants may be raiſed in a climate not their own, provided the difference is not very great; by degrees they become as it were naturalized to it; if once they have produced ſeeds, theſe ſeeds are much leſs apt to miſcarry, and produce hardier plants than ſuch as are brought immediately from their native country. Tobacco, from ſeeds of our own growth, ripens a month ſooner than ſuch as is raiſed from foreign ſeeds.

It was by following nature, that the ingenious botaniſt above-mentioned has been ſo ſucceſsful in bringing up the vaſt variety of plants that have fallen under his care. The *rubus caule unifloro foliis ternatis* was ſome time ago, he tells us, thought incapable of being raiſed about Stockholm, till attention to its natural climate taught to keep it covered with ſnow during the winter and great part of the ſpring. Muſa, the moſt ſpecious plant in nature, had ſtood near an hundred years in the Dutch botanic garden, and could not be made to blow: On conſidering that its native country is Surinam, where the weather is dry for one half year and rainy the next, it was kept long without water, and afterwards kept watered abundantly: It now flowered, and perfected its fruit; and by the ſame management another Muſa was made to flower the next year.

He obſerves, that we can eaſily imitate nature in regard to earth, water, and the degree of heat; and wiſhes we could equally imitate her in the renewals and agitations of air. This alſo it is in the power of art to effect. The principle, that warm air aſcends above cold, affords means of obtaining conſtant changes and ſucceſſions of air wherever there is warmth and cold.

Dr. Hales has applied this principle to the improvement of common hotbeds. If an aperture is made in the top of one end of the frame, and at the bottom of the other, and a deſcending pipe inſerted into this laſt, a ſtream of freſh air will paſs continually over the ſurface of the bed. This air may be warmed before its admiſſion, by carrying the pipe, that conveys it, through the hot dung.

What is here effected by the heat of dung, may be done in hot-houſes by that of fire.

are often found to participate of Nitre; and thoſe on the ſea-coaſts, of marine Salt, though no marks of either of thoſe Salts can be diſcovered in other plants of the ſame ſpecies raiſed in different ſoils (*c*). From inattention to this circumſtance, ſome of thoſe who called chemiſtry in aid for the examination of vegetables, have erroneouſly aſcribed to all the plants of one ſpecies, ſaline ingredients which had been caſually abſorbed by an individual. Vegetables.

Plants differ likewiſe remarkably in their quality at different periods of their growth. Thus ſundry roots, which examined early in the ſpring, are found to be highly aromatic (*d*), become leſs and leſs ſo in proportion as the leaves and ſtalks and age.

fire. A pipe, heated by the fire, and reaching to a conſiderable height in the houſe, will occaſion a continual circulation of the air in the houſe, that which is warmed in the pipe aſcending, whilſt the colder air at the bottom comes in to ſupply its place, and receiving warmth from the tube, aſcends in like manner, and this uninterruptedly whilſt the heat continues. If the lower part of the pipe is made to communicate with the external air, it will bring in freſh. If the fire-place opens, immediately or by a pipe, into the houſe, the colder part of the air at the bottom will paſs off through the fire (for fire requires a large quantity of air for its ſupport,) whilſt freſh air is brought in and warmed by the other pipe.

Stronger and more ſudden agitations of air, ſufficient to raiſe a moderate wind among the plants, may be obtained occaſionally by mechanic impulſe. I have made the outer and inner doors of the room, with a proper cavity between them, ſerve for a ventilator, the cheek which bounds the cavity on one ſide being made of a circular curvature, that the inner door, in its motion backwards and forwards, may fit cloſe to it all the way. The inner door is furniſhed with a valve at bottom, which on pulling the door backwards receives a part of the air of the houſe into the cavity, and with another at top, by which, on puſhing the door forwards, the air is forced out again with ſtrength enough to give a conſiderable ſhake to almoſt all the plants in a large hot-houſe. The outer door alſo is furniſhed with valves, through which, by a few reciprocations of the inner door, the external air is plentifully pumped in, or the internal air driven out, all the valves being made to open occaſionally outwards or inwards, and ſecured on either ſide with buttons.

(*c*) *Vegetables imbibe Salts from the ſoil.*] Henckel, in his *Flora ſaturnizans*, carries this point ſo far, as to ſuppoſe that plants growing about mines or in metallic countries, abſorb from the earth particles of the ſeveral metals whoſe ores are there to be met with, and that plants are ſometimes thus naturally impregnated with Silver and with Gold, as well as with the baſer metals, and with the poiſonous metallic body Arſenic. He mentions ſeveral fabulous ſtories in proof of this opinion. There is not one well-atteſted example of any metallic ſubſtance being diſcovered in vegetables, except Iron; of which a minute portion has been found in all the vegetable matters that have been examined with that view, whatever kind of ſoil they were produced in. See p. 76.

The ſame celebrated chemiſt imagines, that roots or ſeeds planted in earths that have been impregnated with colouring matters, will imbibe the colour, and tranſmit it unaltered to the flowers. This alſo is extremely queſtionable. If the ſtems indeed of ſundry white flowers, as the Lily, be placed in certain coloured liquors, as the red or purple juices of berries, ſo much of the juice is ſaid to ariſe in a few hours thro' the ſtem into the veſſels of the flower, as to variegate it with ſtreaks of its own colour. But when the plant is taken entire, and its roots ſet in the ſame coloured liquors, the flower receives from them no viſible tincture: The colouring matter in one caſe paſſing barely through the tubulous ſtem, whilſt in the other, it paſſes through the whole vaſcular ſyſtem, and is changed and aſſimilated by the digeſtive powers of the plant.

(*d*) *Roots, in ſpring.*] The roots of plants have been generally ſuppoſed to be in their greateſt

Vegetables.

ſtalks ariſe: The leaves in the mean time grow ſtronger and ſtronger, till the flowers are ready to burſt forth, and then begin to loſe of their fragrancy, as if the finer and more grateful parts were tranſmitted to the flowers and ſeeds. How different are the common culinary herbs at different ages; and fruits in their different ſtates of maturity.

NATIVE PRINCIPLES *of* VEGETABLES.

Their native principles;

THE ſubſtances naturally contained in vegetables, and ſeparable from them by art, are, (1.) Gum, (2.) Reſin, (3.) a ſubtile Oil, (4.) Camphor, (5.) a groſs Oil, and (6.) a ſaline matter; together with (7.) Phlegm or Water, intimately blended with theſe, and which ſerves as a vehicle to dilute and fit them for circulation; and (8.) an earthy ſubſtance, which is the baſis of all vegetable bodies, the principle on which their firmneſs and ſolidity depends.

Gum.

GUMS are inſipid and inodorous ſubſtances, ſoluble in water into a viſcous or glutinous liquid, not acted upon by vinous ſpirits or by Oils (*e*), not volatile in the heat of boiling water, not fuſible or inflammable in the fire. They are commonly called *Mucilages* when ſoftened with water, or when conſidered as blended with the other principles of vegetables; and *Gums*, when ſeparated in a pure ſolid dry ſtate.

RESINS

greateſt degree of perfection in the autumn, when the leaves begin to fall off: But this appears rarely, if ever, to be the caſe. Thus much ſeems univerſally to obtain, that when plants have run up to flower, the roots prove much weaker in ſmell and taſte, and their juices more crude and watery than before that period; that after flowering, the roots of annual and biennial plants continue to grow more and more effete till they periſh; and that thoſe of perennials do not recover their vigour till the enſuing ſpring: It is when the root is going to puſh forth its firſt leaves, that it is ſtrongeſt in medicinal as well as vegetative power. Whether biennial roots are moſt vigorous at the falling of the firſt year's leaves, or the ſhooting of the next, is not quite ſo clear.

The moſt perfect ſtate of the leaves of plants is ſaid to be juſt before the appearance of the flower. This rule alſo is very far from being general: Perhaps it holds principally, if not ſolely, in the herbaceous plants, or thoſe which die to the ground in winter. The leaves of Mint, and ſundry other aromatic herbs, diſcover in the ſpring very little of the ſtrong flavour by which they are ſo eminently diſtinguiſhed in their more advanced ſtate; whilſt on the contrary, thoſe of the Sweet-briar, and ſome other odoriferous ſhrubs, loſe much, before they flower, of the fragrance which they had in the ſpring. The young buds, or rudiments of the leaves of the black poplar tree have a ſtrong fragrant ſmell approaching to that of Storax, and yield, on a chemical analyſis, a reſinous extract not greatly different from that valuable exotic Reſin: By the time that the leaves have attained to their full growth, their fragrance is exhauſted. The fineſt Tea, according to the accounts of travellers, is the earlieſt leaves of the Shrub, gathered whilſt they are young; thoſe which ſucceed them, and the firſt ones when grown old, having leſs and leſs of the admired flavour.

(*e*) *Gums not acted upon by Oils.*] Though pure dry Gums are not miſcible with, or in the leaſt affected by Oils, yet when ſoftened with water into a mucilage or thick liquid, they unite eaſily by triture or agitation, with Oils both expreſſed and diſtilled, into a milky or butyraceous compound; which may be largely diluted with water, without any ſeparation of the Oil and Gum. From this property of Gum, we are enabled to mingle oily and reſinous bodies with watery liquors for medicinal uſe, more effectually than by any other means as yet diſcovered.

RESINS are ſoluble in vinous ſpirits and in Oils, not acted upon by water, not volatile in the heat of boiling water, fuſible in a ſmall degree of heat, and readily inflammable on the contact of any flaming or ignited body: Of themſelves they have no ſmell; but they often retain, or have induſtriouſly preſerved in them a part of the odorous principle, and are nevertheleſs looked upon as pure Reſins. In their liquid ſtate, they are called *Balſams*; and when combined with any conſiderable proportion of Gum, *Gummy-reſins.* NATIVE PRINCIPLES. Reſin,

The SUBTILE OILS are ſapid and odorous, ſoluble in Spirit of Wine, miſcible with the groſſer Oils, not miſcible with water, totally volatile in the heat of boiling water, very readily inflammable. It is in theſe, that the odours of almoſt all vegetables, and of many the taſtes alſo reſide; whence they are called *Eſſential.* The Oil itſelf however is not the immediate principle of ſmell: It contains a far more ſubtile ſubſtance, of which the Oil is only the matrix, on which the ſmell wholly depends, and whoſe particular nature is wholly unknown. If an odorous Oil be expoſed for a length of time to the air, it will almoſt entirely loſe its ſmell without ſuffering any conſiderable diminution of its weight (*f*). Eſſential Oil,

CAMPHORS are ſolid concretes, ſoluble in vinous ſpirits, in Oils, and in mineral acids, particularly the nitrous, not acted upon by water, totally volatile in the heat of boiling water, eaſily fuſible, highly inflammable, ſubliming unchanged in cloſe veſſels, without leaving any feces. Their ſolubility in Aqua fortis, and their totally ariſing not only in diſtillation with water, but when committed to the fire without any addition, readily diſtinguiſh them from Reſins and coagulated Oils, with which they have often been confounded. They have always a ſtrong pungent ſmell, reſembling that of the ſubject, and do not loſe their ſmell like eſſential Oils, but retain it ſo long as any of the Camphor itſelf remains unexhaled. Camphor,

The GROSS OILS are inſipid and inodorous, not miſcible with water or with vinous ſpirits, but readily with eſſential Oils, not volatile in the heat of boiling water, inflammable in the fire. Theſe are uſually extracted by expreſſion, and hence diſtinguiſhed by the name of *Expreſſed* or *Expreſſible Oil.* Expreſſed Oils,

The native SALTS of vegetables have the general characters of ſaline bodies, taſte, and ſolubility in water: Some diſſolve likewiſe in Spirit of Wine. They are of different kinds, ſweet, auſtere and acid; but never alcaline, all alcaline Salts being creatures of art. Salts.

Gums and Mucilages are found in greater or leſs quantity in all the vegetables that have been examined. The Oils and Salt are in many deficient, or in ſo ſmall proportion as not to be ſeparable from the other principles but by a deſtructive analyſis, by a degree of fire which deſtroys the texture of the plant, and all its native qualities. No eſſential Oil, and much leſs a Camphor, is to be expected from inodorous vegetables; and no conſiderable quantity of ſaline matter from any but thoſe which are manifeſtly very ſweet or very acid.

Vege-

(*f*) *Odorous Oils loſe their odour in the air.*] Their ſmell is likewiſe in great meaſure imbibed by water: On agitating the Oil repeatedly with freſh parcels of water, nearly all its ſmell will be by degrees communicated to the aqueous fluid, without much loſs of the ſubſtance of the Oil. This ſubtile odoriferous principle is called by Boerhaave *Spiritus rector* or the preſiding Spirit of plants.

NATIVE PRINCIPLES. Juices naturally extravafated.

Vegetables when arrived at perfect growth, are ſubject, like animals, to ſpontaneous ruptures of the veſſels, and an effuſion of their contents, and to more profuſe diſcharges on being wounded. The various Gums, Reſins, Balſams and gummy Reſins, brought from abroad for medicinal or mechanic uſes, are the natural juices of herbs, ſhrubs and trees, exuding in the warmer climates, ſpontaneouſly or from inciſions. Many of theſe kinds of products may be collected alſo in our own country. Thus, the Cherry and the Plum-tree bleed in ſummer a glutinous fluid, which on the exhalation of its aqueous part, concretes into a ſolid Gum; and thus the Pine and the Fir ſhed their balſamic or oily and reſinous juices. Our Poppies bleed Opium from their heads, Angelica, Maſterwort, Lovage, *&c.* aromatic Gummy-reſins from their roots.

Extracted by art.

The active principles of vegetables are ſeparable more effectually and more perfectly by art, not only from the groſs earthy matter, but from admixtures of one another. As gummy and ſaline ſubſtances diſſolve in water, they may be extracted from all the plants that contain them, by infuſion in that menſtruum; aud in like manner, eſſential Oils and Reſins are got out by vinous ſpirits: Where oily and reſinous matters are in large proportion, they are ſometimes ſeparable from the ſubject by boiling it in water, the Oil or Reſin melting out by the heat, and ariſing to the ſurface, indiſſoluble in the aqueous liquor: Eſſential Oils and Camphor, which exhale in the heat of boiling water, may be collected in the watery vapour, pure from all the other principles of the plant. By theſe operations, the native juices of all vegetables, the principles in which their ſmell, their taſte, their medicinal activity, and their colours (*g*) reſide, are obtained unaltered: The plant ſtill preſerves its original form and ſtructure, though robbed of all its peculiar qualities.

I. GUMS

(*g*) *Colours.*] Though many vegetables give out their colours, along with their ſmells and taſtes, to watery or to ſpirituous menſtrua, or to both; there are not a few whoſe colour is extracted neither by one nor by the other, nor by a mixture of the two; the blue flowers of Cyanus for inſtance. And indeed of the greater part of vegetable colours it is hard to ſay whether they depend upon a reſinous or a gummy matter, or on ſome diſtinct principle.

Water impregnated with certain ſaline ſubſtances extracts the colouring matter of ſundry vegetables more effectually than pure water could do: A ſubſequent addition of certain other Salts renders it incapable of keeping in diſſolution thoſe particles which it had before taken up, and which of courſe muſt now ſettle by degrees to the bottom. Thus, if to a yellow decoction of Turmeric or a red one of Madder roots, made in a watery ſolution of fixed alcaline Salt, we add a proper quantity of ſolution of Alum; the yellow particles of the one and the red of the other will ſeparate and ſubſide, and leave the liquor clear. At the ſame time, the acid of the Alum being abſorbed by the alcaline Salt, the aluminous earth falls down with the colouring matter, and dilutes and brightens the colour. Theſe kinds of preparations are commonly called *Lakes*.

On what principle the tinging matter is here precipitated is not known. It ſeems as if the tinging particles themſelves had ſuffered an alteration from the action of the two Salts; for though the liquor remaining after the precipitation (which is no other than a ſolution of vitriolated Tartar) gains no colour from the Lake, it extracts a ſufficiently deep tincture on digeſting it with a freſh parcel of the ſubject which the Lake was made from.

Solution of Alum precipitates likewiſe many

I. GUMS *and* RESINS.

GUMS and RESINS.

WHEN Resins or essential Oils are intimately blended with gummy and saline matter, as they generally are in vegetables, a part of the Resin or Oil will dissolve in water along with the Gum, and a part of the Gum will dissolve in Spirit of Wine along with the Resin. Hence spirituous tinctures made from plants are not purely resinous, but contain a part of their mucilage, whilst watery infusions participate of the Resin and Oil, and consequently of the taste, smell, and medicinal virtue, residing in those principles. There is scarcely any vegetable, however resinous, that does not give out some part of its virtue to water.

Tinctures and infusions.

Pure resinous tinctures.

If plants be infused or boiled in water till that menstruum has extracted all it is capable of doing, and afterwards digested in Spirit of Wine, the spirituous tincture thus obtained, will be merely resinous: These kinds of tinctures made from odoriferous or aromatic vegetables, have generally little flavour of the subject, the more subtile part of the Resin, or essential Oil, being either previously dissolved by the water along with the gummy or saline matter, or dissipated during the boiling——In like manner, if Spirit of Wine be applied at first, it will dissolve the Resin and the Oil, and leave undissolved a part of the Gum or Mucilage, which may now be extracted by water, pure from any other principle, perfectly insipid and inodorous.

Pure gummy infusions.

General observations.

The watery extractions from vegetables are named *infusions* or *decoctions*, according as they are prepared by macerating or infusing, or by boiling the plant in the water: The spirituous are named *tinctures*, *essences*, or *elixirs*, according as they have a less or greater degree of consistence, or are less or more loaded with the soluble parts of the subject; when as thick as the native balsams or resinous juices, they are called *spirituous balsams*. The method of making these preparations is too familiar to require any explanation in a work of this kind: What substances are adapted to one or the other treatment, will appear from the examination of particular bodies in the following sections. We shall here only observe in general, that though vinous spirits extract the odorous part of vegetables far more perfectly than water, yet the spirituous tincture discovers frequently less smell than the watery infusion, the spirit seeming to cover or conceal the smell; that both water and spirit dissolve most readily the finer and more grateful parts of plants; that heat promotes the action of both menstrua, and enables them more speedily to take up, along with those, the grosser and more ungrateful matter. If Sena, for instance, be infused in cold, or for a little time in warm water, the liquor will purge far more mildly than an infusion made in hot water for a longer time, though both infusions be reduced to the same degree of strength, in regard to the quantity of matter dissolved in them, by a suitable evaporation of the fluid.

By

many vegetable colours that have been extracted by water alone; and in this case also, a part of the earth of the Alum falls down along with the colouring particles. On what foundation this happens we do not know. The whole affair requires a more thorough examination than has hitherto been bestowed upon it.

GUMS and RESINS. By totally exhaling the fluid, the gummy or reſinous matter which it had taken up from the plant, is obtained in a ſolid form: Theſe preparations are called, not Gums and Reſins, as not being purely ſuch, but *watery* and *ſpirituous* or *gummy* and *reſinous extracts*. An extract made by water, from a plant that has previouſly undergone the action of ſpirit, may properly be called Gum or Mucilage; and one made by ſpirit, after water has performed its office, may be looked upon as a pure Reſin. A pure Reſin may be procured alſo by evaporating a tincture made in ſpirit at firſt, till it begins to grow thick, and then adding a quantity of water: The Reſin, indiſſoluble in that menſtruum, will ſeparate and fall to the bottom, whilſt the gummy parts before mixed with it, remain ſuſpended in the water.

Watery and ſpirituous extracts.

In the making of extracts, it is particularly neceſſary to perform the evaporation with a gentle heat: In many caſes, the liquor may at firſt be kept boiling for a time over an open fire, but as ſoon as the matter begins to grow a little thick, it muſt be removed into a gentler heat, otherwiſe it will ſcarce be poſſible to prevent its burning to the veſſel, and contracting a diſagreeable empyreumatic ſmell and taſte: It is now to be placed in a water-bath, or rather poured into ſhallow flat veſſels, and exſiccated in a warm room.

Draſtic vegetables rendered mild.

In the making of extracts for medicinal uſe, from draſtic vegetables, ſtrong boiling is oftentimes of advantage, as it abates the violence of the medicine, and renders its operation more mild and ſafe. For this purpoſe, the infuſion or decoction of the ſubject ſhould be made with a large quantity of water, that the liquor may be kept the longer boiling before it grows thick: The inſpiſſated matter may likewiſe be diſſolved afreſh, and the coction and inſpiſſation repeated. By this treatment, great alterations are made in vegetables, independently of the diſſipation of their volatile parts. Aſarum, a ſtrong emetic, treated with a large quantity of water, yields an extract which proves merely purgative: If this be diſſolved afreſh, and again inſpiſſated, it loſes its purgative, and acquires a diuretic virtue: By a third inſpiſſation, it is changed from a diuretic to a ſudorific. In like manner, the violent emetic power of the white Hellebore, and the cathartic of the black, are mitigated or deſtroyed by long coction: Tobacco, from a virulent emetic and cathartic, becomes a ſafe pectoral, attenuant and anodyne. The milder purgatives alſo, as Sena and Rhubarb, are proportionably weakened by a like treatment (*h*).

II. ESSENTIAL OILS.

ESSENTIAL OILS. WHEN odorous vegetables are boiled in water for any conſiderable time, their ſmell is loſt both from the plant and from the decoction, the volatile Oil, in which the odour reſides, being diſſipated along with the ſteam of the boiling liquor. If the vapour which exhales, be caught and condenſed in proper

(*h*) *Draſtic vegetables corrected.*] The virulence of draſtic vegetables is undoubtedly deſtroyed or abated by long continued boiling; but that by this proceſs they acquire the excellent diuretic, pectoral, aperient and other virtues aſcribed to them by ſome of the chemiſts, is not quite ſo certain. Whatever may be in this, the preparations are by no means fit for general uſe, as it is impoſſible to adjuſt them to any ſtandard in point of ſtrength.

proper veſſels, as the common ſtill, the Oil ſeparates from the diſtilled water, and ariſes to the ſurface or ſinks to the bottom according to its gravity. Where the quantity of Oil is very ſmall, it is moſt commodiouſly taken off with a little Cotton: Where the quantity is large, it is parted from the water by means of ſpout-receivers and ſeparating glaſſes contrived for this uſe. ESSENTIAL OILS.

Theſe Oils are obtainable only from odoriferous vegetables, but not equally from all of that claſs, nor proportionably to their degree of fragrance. The Violet, the Lily, the Narciſſus, the Hyacinth, and ſome other flowers of a delightful ſmell, even the damaſk Roſe itſelf, ſcarcely yield a drop of Oil, unleſs ſome hundred weights are committed to the operation at once: From ſuch quantities I have ſeen, in Italy, a little Oil obtained from them all. Subjects.

Eſſential Oils may be conſidered as little other than ſubtile liquid Reſins or Balſams. By digeſtion or heat, they actually change into thick Balſams, and at length into perfect, ſolid, brittle Reſins: Diſtilled again in this ſtate, they ſtill yield, like moſt of the natural Reſins, a portion of fluid Oil, the groſſer reſinous matter remaining in the ſtill. By certain treatments, and by the admixture of concentrated mineral acids (*i*), a like change is producible in theſe Oils inſtantaneouſly. Analogy with Reſins.

In moſt of the herbs, flowers, ſeeds, barks, or roots, that yield an eſſential Oil, the microſcope diſcovers ſhining reſinous particles: If theſe be carefully picked out and ſeparated, the remaining matter will no longer yield a ſingle drop of Oil. All herbs and trees, in proportion as they are the more reſinous, yield the more Oil: The Larch, the Pine, and the Fir, which abound with Reſin, abound alſo with Oil, whilſt the Birch, the Beech, and the Oak, are as deficient in one as in the other. The Turpentine and Fir-tree yield the moſt Oil of any vegetable ſubſtance known: Hence the Oils of theſe are employed for the ſophiſtication of the more rare and coſtly. Next follows Savin, which affords an ounce and a half upon ſixteen ounces. Cloves, Nutmegs, *&c.* give the next largeſt quantity: After theſe come Mint, Marjoram, Spike, Saſſafras, *&c.* all which yield a conſiderable proportion. The Oil of Juniper-berries is ſold very cheap, but we muſt not conclude from hence that theſe berries afford any very large quantity, much the greateſt part of it being common Oil of Turpentine: Only about ſix ounces of Oil were obtained from ſixteen pounds of the berries (*k*).

Eſſential Oils reſide chiefly in the rinds, fine leaves, flowers and ſeeds of plants, and commonly in particular cells diſtributed through thoſe parts. In freſh vegetables, the Oil is blended with watery moiſture: And hence when recent Their ſeat.

(*i*) *Eſſential Oils with acids.*] Theſe Oils unite difficultly with alcaline Salts, but very readily with the concentrated mineral acids: With theſe laſt they form a thick butyraceous or ſolid concrete, which when freed from the redundant acid by ablution with water, proves in many reſpects ſimilar to Reſins: It has a reſinous taſte, liquefies in a ſmall heat, and totally diſſolves in rectified Spirit of Wine. A great heat and ebullition, with a diſcharge of noxious fumes, commonly enſue upon mixing the Acid and the Oil: By a haſty addition of the concentrated nitrous ſpirit, moſt Oils may be actually ſet on fire. See page 195.

(*k*) *Quantity of Oil.*] An account of the quantity of Oil obtained from different ſubſtances, may be ſeen in the *Practical Chemiſtry*, page 260.

ESSENTIAL OILS.

Differences according as the ſubject is uſed freſh or dry.

recent plants are commited to diſtillation, very little Oil is obtained in a ſeparate ſtate. Dry plants yield more Oil, but here again there is another inconvenience, the more ſubtile, volatile and fragrant parts exhaling in the exſiccation along with the aqueous humidity. Moſt eſſential Oils, however, are uſually diſtilled from dry plants: The exſiccation ſhould be performed with care, not in the ſun, much leſs by a fire, but in a moderately warm ſhady place (*l*).

Of the difference betwixt the Oils obtained from recent and dry vegetables, we have a notable inſtance in Citron-peels. Let the freſh peel be diſtilled in the heat of a water-bath without addition, and the dry peel with water in the common manner: Compare the two Oils together, and they will be found extremely different; the firſt highly ſubtile, volatile, penetrating, and truly ethereal; the latter far groſſer, of a thicker conſiſtence, not near ſo agreeable in ſmell or taſte, approaching more to the nature of Reſins or Balſams, the conſiſtence of which laſt it acquires ſpontaneouſly upon keeping for a few years. The ſame thing holds alſo, though not in an equal degree, in all odoriferous vegetables: Even from freſh ones we obtain two kinds of eſſential Oil, one groſſer, and the other more ſubtile.

Method of obtaining them.

In the diſtillation of eſſential Oils, regard muſt be had to their degree of volatility or ponderoſity; ſome requiring for their elevation a conſiderable fire, which would be injurious to others, by diſſipating or altering their more ſubtile parts. A few, as thoſe of Citron-peel, and ſome tender leaves and flowers, may be commodiouſly drawn in a water-bath without any addition (*m*); but much the greater number require the ſubject to be boiled in water over a naked fire. The water ſerves here both as a menſtruum to diſſolve and diſunite the gummy and mucilaginous parts, in which the oily ones were entangled, and as a vehicle to carry up the Oil; as alſo, to ſecure the plant from burning to the veſſel. The quantity of water may be about three or four times as great as that of the ſubject to be diſtilled.

Uſe of ſaline additions.

Compact ſubſtances are to be previouſly macerated in the water for three or four days, that the Oil may be the more effectually extricated. To every ten quarts of the water may be added two or three handfuls of common Salt: This not only promotes the action of the water, and prevents the fermentation or putrefaction, which vegetable infuſions are liable of themſelves to run into, but likewiſe increaſes the weight of the fluid, renders it capable of bearing a greater

(*l*) *Exſiccation of plants for eſſential Oil.*] Plants are rarely dried with us, in order to increaſe the yield of their eſſential Oil.

(*m*) *Diſtillation of Oils in a water-bath.*] The eſſential Oils of many odoriferous plants are eaſily obtained in the higheſt degree of perfection, by diſtilling them with the vapour of water kept ſomewhat below boiling. The Oil of Lavender flowers, of Roſemary-tops in bloom, thus diſtilled, are quite colourleſs, very light, in appearance almoſt like pure Spirit of Wine, exquiſitely retaining the native odour of the flowers, without any of that ſtrong diſagreeable ſcent perceived in thoſe obtained by violent coction of the plant in large quantities of water. The common ſtill is eaſily adapted to this purpoſe, by fixing a hair-cloth immediately over the ſurface of the water, and placing the herb upon it, ſo as to ariſe quite into the head.

heat, and thus enables it to elevate more readily the groſſer and more ſluggiſh Oils (*n*). ESSENTIAL OILS.

Some employ for theſe purpoſes other ſaline additions, as regenerated Sea-ſalt, the Sal digeſtivum, Glauber's Sal mirabile, mineral acid ſpirits, crude Tartar, and fixed alcaline Salts. The two laſt are by no means to be commended: Tartar, as containing itſelf a groſs oily matter, and being very difficult of ſolution, can at beſt do little ſervice; and alcalies, though they powerfully promote the reſolution of the ſubject, yet at the ſame time entangle and detain the Oil, forming with it a ſaponaceous concrete. With regard to acids, Homberg relates, that from Fennel ſeeds and Roſes a much larger quantity of Oil was obtained when Spirit of Salt or Oil of Vitriol were added, than when the ſubjects were macerated for an equal length of time without thoſe additions. But if the Oil thus obtained was really in greater quantity it was ſurely inferior in quality: Theſe acids alter the quality of all diſtilled Oils, and diſpoſe them to a reſinous conſiſtence.

Some vegetable matters, particularly the rinds of Citrons, Lemons, Oranges, yield a part of their eſſential Oil upon bare inciſion. By this ſimple proceſs, an Oil is prepared from Citron-peel, in Italy, more ſubtile and volatile than that obtained by diſtillation. The fruit is rolled upon a plate ſtuck full of ſharp points; by which, many thouſands of punctures are made at once in the rind, and the oily cells laid open: The Oil which thus exudes, is received in a veſſel placed underneath, and what ſtill remains in the peel is afterwards extracted by diſtillation. Hoffman relates, that the Italian Oil of Citron-peel, or *Oleum de cedro*, is ſo light as to ſwim upon Spirit of Wine; but I have always obſerved it to fall to the bottom: Probably he made the experiment with a phlegmatic ſpirit. By inciſion.

The eſſential Oils obtained from different vegetables, differ from one another, not only in ſmell and taſte like the vegetables themſelves, but in ſundry other reſpects. Some are ſo heavy as to ſink in water; ſuch are thoſe of the Indian aromatics, Cinamon, Cloves, Saſſafras, *&c.* Others, and indeed the greater number, ſwim on water (*o*). The Oils of Lavender, Balm, Roſemary, Savin, Differences of the Oils of different vegetables.

(*n*) *Salt renders the water ſuſceptible of greater heat.*] In this intention the addition of Salt may poſſibly be of ſome uſe; but what ſervice it is capable of doing during the maceration does not appear. In that part of the operation, it ſhould ſeem to be rather injurious, as it tends to harden inſtead of ſoftening the ſubject, and to impede inſtead of promoting the action of the water. There is no occaſion for any other addition than plain water: The moſt compact woods, duly raſped or ſhaved, will be ſufficiently penetrated by maceration in water, and the ſubſequent diſtillation with a boiling heat, to give over all the eſſential Oil they contain. With regard to the preventing of putrefaction, it ſhould ſeem, that in proportion as the Salt prevents that proceſs, it prevents the effect expected from the maceration; the opening, as it is called, or reſolution of the ſubject here required, being no other than the early ſtage of a general proceſs which in its advanced ſtate is termed putrefaction.

(*o*) *Gravity of Oils.*] As there are conſiderable differences in the gravity of the Oils of certain vegetables, ſome have thought to diſtinguiſh, upon this principle, the genuine Oils from the ſophiſticated, or the Oil of one ſubſtance from that of another. A further examination ſhews, that the

ESSENTIAL OILS.

Savin, if carefully diſtilled, prove limpid and colourleſs, whilſt that of Spike is greeniſh yellow; of Thyme and Savoury, browniſh; of Wormwood, brown or greeniſh black; of common Camomile, blue; of Milfoil, ſometimes blue and ſometimes green; of Cloves, Cinnamon, Saſſafras, at firſt colourleſs, changing by age to a yellowiſh, and at length to a reddiſh-brown colour. Thoſe of Aniſeeds and Rue congeal or become conſiſtent in cold weather, whilſt moſt of the others preſerve their fluidity.

How to be kept.

Eſſential Oils, as being fraught with a very volatile odoriferous principle, ſhould be carefully preſerved from the air. They are beſt kept in glaſs bottles fitted with ground glaſs ſtoppers, not in a warm, but in a cool and dry place. Warmth promotes not only the diſſipation of their ſubtile fragrant part, but likewiſe their diſpoſition to become reſinous.

Their adulterations detected.

The dearer eſſential Oils are frequently adulterated with Oil of Turpentine, expreſſed Oils, Spirit of Wine, *&c.*——An admixture of ſpirit may be diſcovered, by pouring a little of the ſuſpected Oil into water: If the water grows milky, and the quantity of Oil viſibly leſs, we may be ſure that this adulteration has been practiſed: If no milkineſs appears, we may be ſatisfied that the Oil has no mixture of ſpirit——Expreſſed Oils are diſcovered by adding a quantity of ſpirit, which will diſſolve the eſſential, and leave the expreſſed behind——Oil of Turpentine is diſtinguiſhed by moiſtening a bit of cloth with the mixed Oil, and ſetting it in a gentle warmth: The ſmell of the genuine Oil will ſoon be diſſipated, that of the Turpentine remaining. The Oil of Turpentine is apt likewiſe to diſſolve the Oil painting on the bottles in which theſe kinds of preparations are uſually kept in the ſhops (*p*).

Though

the gravity can be no certain teſt; that one and the ſame ſubject yields, at the beginning and end of the diſtillation, Oils more different in gravity than thoſe obtained from different ſubjects. How nearly ſome eſſential Oils, that are very diſſimilar in their other qualities, approach in ſpecific gravity, and how nearly the groſs expreſſed Oils approach to ſome of the eſſential, will appear from the following table. The proportional weight of rain-water, as in other tables of this kind, is 1,000.

Eſſential Oil	of Saſſafras -	1,094
	of Cinnamon -	1,035
	of Cloves - -	1,034
	of Fennel - -	,997
	of Dill - - -	,994
	of Penny-royal -	,978
	of Cummin - -	,975
	of Mint - - -	,975
	of Nutmegs - -	,948
	of Tanſy - - -	,946
	of Caraway Seeds	,940
	of Origanum -	,940
Eſſential Oil	of Spike - - -	,936
	of Roſemary -	,934
	of Juniper-berries	,911
	of Oranges - -	,888
	of Turpentine -	,792
Expreſſed Oil	of Linſeed - -	,932
	of Olives - -	,913
	of Rapeſeed - -	,913

Theſe are the gravities of the particular ſpecimens examined; and of moſt of them we ſhall ſeldom perhaps meet with another ſpecimen, that does not differ as much from the ſame Oil in the table, as that in the table does from the Oil next to it.

(*p*) *Adulteration of eſſential Oils.*] As all eſſential Oils agree in the general properties of ſolubility in Spirit of Wine, indiſſolubility in water, miſcibility with water by the mediation of Mucilages, Sugar, or yolk of eggs, volatility in the heat of boiling water, *&c.* it is plain they may be variouſly mixed with one another, or the dearer ſophiſticated

Though all eſſential Oils diſtil freely along with boiling water, there are many which cannot be elevated by the heat that boiling water communicates through the ſides of another veſſel. If Oils already ſeparated from the ſubject, be committed to diſtillation by themſelves, there are few that will begin to ariſe, till the heat has become ſtrong enough to alter or deſtroy their peculiar flavour, and give them a burnt ſmell and taſte. It is obſervable, that the moſt ſubtile and volatile of the eſſential Oils require a conſiderably ſtronger heat to make them boil than water does (*p*). ESSENTIAL OILS. Their habitude to fire in different circumſtances.

WATER agitated with eſſential Oils, imbibes a portion of that ſubtile principle on which their odour depends, ſo as to become notably impregnated with their flavour. Hence the water, which diſtils along with the Oil participates always of the ſmell of the plant, and of its taſte alſo, where the taſte depends upon the oily principle. The diſtilled waters of ſome ſubſtances, as Cinnamon, Cloves, Cardamoms, Aniſeeds, Fennel-ſeeds, *&c.* poſſeſs the diſtinguiſhing Diſtilled waters.

phiſticated with the cheaper, without any poſſibility of diſcovering the abuſe by any trials of this kind.

And indeed, it would be of little advantage to the purchaſer, if he had infallible criteria of the genuineneſs of every individual Oil. It is of as much importance that they be *good* as that they be *genuine*; for I have often ſeen genuine Oils, from incurious diſtillation, and long and careleſs keeping, weaker both in ſmell and taſte than the common ſophiſticated ones.

The ſmell and taſte ſeem to be the only certain teſts that the nature of the thing will admit of. If a bark has in every reſpect the appearance of good Cinnamon, and is proved indiſputably to be the genuine bark of the Cinnamon-tree, yet if it wants the Cinnamon flavour, or has it but in a low degree, we reject it; and the caſe is the ſame with the Oil. It is only from uſe and habit, or compariſon with ſpecimens of known quality, that we can judge of the goodneſs either of the Drugs themſelves or of their Oils.

Moſt of the eſſential Oils, indeed, are too hot and pungent to be taſted with ſafety, and the ſmell of the ſubject ſo much concentrated in them, that a ſmall variation in this reſpect is not eaſily diſtinguiſhed; but we can readily dilute them to any aſſignable degree. A drop of the Oil may be diſſolved in Spirit of Wine, or received on a bit of Sugar and diſſolved by that intermedium in water: The quantity of liquor which it thus impregnates with its flavour, or the degree of flavour which it communicates to a certain determinate quantity, will be the meaſure of the degree of goodneſs of the Oil.

(*p*) *Habitude of Oils to fire.*] Many Oils, in their firſt diſtillation from the ſubject, carry up with them a portion of groſs reſinous matter; which, if too ſtrong a heat has been uſed in the operation, proves ſometimes very conſiderable. On more carefully diſtilling them with water a ſecond time, the Reſin remains behind, and is generally found to be inſipid and inodorous: The Oil by this means becomes more limpid and pure, and at the ſame time is in good meaſure freed from any ungrateful empyreumatic taint which it might before have received from the fire. In this rectification of Oils, whether debaſed in the diſtillation itſelf or by age, ſome have employed common Salt, Sal mirabile, and other additions, which do not appear upon experiment to be of any advantage.

Eſſential Oils, diſtilled in a retort without water, firſt give over a thin fluid Oil, ſlightly empyreumatic, a thicker one remaining in the bottom. If this be further urged, greateſt part of it ariſes, only a little coaly matter being left; but the ſpecific flavour of the ſubject is deſtroyed, and the diſtilled Oil has only a burnt ſmell and taſte, like that of the empyreumatic ones to be treated of hereafter.

ESSENTIAL OILS.

guiſhing taſte as well as the ſmell of the ſubjects; whilſt thoſe of Roſes, Wormwood, and many others, have nothing but the ſmell; the bitterneſs of Wormwood, the aſtringency of the Red roſe, and the purgative quality of the damaſk, reſiding in a fixed matter, incapable of ariſing in diſtillation.

Subjects for diſtilled Waters.

Water receives a ſtrong impregnation by this proceſs, not only from thoſe odorous vegetables which abound with Oil, but likewiſe from the more tender flowers which yield no actual Oil unleſs immenſe quantities are committed to diſtillation at once, as the Jaſmine and the Lily. Vegetables in general, poſſeſſed of any conſiderable ſmell, flavour, aromatic warmth or pungency, give over thoſe qualities to Water in diſtillation; whilſt bitterneſs, ſweetneſs, aſtringent, purgative, emetic, unctuous, mucilaginous virtues remain behind in the ſtill. How ridiculous is it to diſtil Waters, as many diſpenſatories ſtill direct, from ſubſtances of this laſt claſs, which give over nothing of their virtues.

General obſervations.

Waters diſtilled from one ingredient are called *ſimple*; from more than one, *compound*. Freſh juicy vegetables are ſometimes diſtilled by the heat of a Water-bath, without any additional liquid; that heat being inſufficient to burn or ſcorch the plants, whilſt it elevates great part of their flavour along with their native moiſture (*r*). The method of performing the diſtillation is too com-

(*r*) *Diſtillation in a Water-bath.*] It has been commonly ſuppoſed that a heat much leſs than that of a Water-bath is ſufficient to elevate the fragrant parts of vegetables: That all thoſe plants, which diffuſe their active effluvia through the open air, will give out the ſame effluvia, when included in cloſe veſſels, and expoſed to a heat no greater than that which obtains in the atmoſphere in ſummer.

" Take, ſays a celebrated chemiſt, " Roſemary freſh gathered, in its perfec- " tion, with the morning dew upon it, " and lay it lightly and unbruiſed upon " the broad round plate within our little " cylindrical furnace .... Then cover the " furnace with its large conical ſtill-head, " and apply a glaſs receiver to the noſe " thereof. In the fire-place of the furnace " put a lighted coal, that does not ſmoke, " and raiſe up an equable degree of heat, " not exceeding eighty-five degrees on " Fahrenheit's thermometer; and let this " heat be kept up ſo long as any liquor " comes over .... This Water contains " the elementary Water and preſiding Spi- " rit of the plant, a ſpirit ſmall in bulk but " rich in virtue, and exhibiting the ſpecific " ſmell and taſte, and particular virtue of " the ſubject; leaving the remainder ex- " hauſted ..... Hence we may underſtand " that the various, peculiar, and often ſur- " prizing virtues of plants, may be widely " diffuſed through the air, *&c.* * "

I have ſubmitted to this proceſs Roſemary and many other aromatic herbs, without the promiſed ſucceſs: The diſtilled liquors in general had hardly any thing of the fine flavour of the ſubject: Even when the heat of a boiling Water-bath was made uſe of, there were very few plants that gave over to the diſtilled liquor any conſiderable ſmell or taſte. It is by the aſſiſtance of the free ventilation of the open air, that the ſun's heat robs odoriferous plants of their fragrancy; and even when thus aſſiſted, it leaves their other active virtues unhurt: Theſe alſo the humid air of the mornings and evenings diſſolves and imbibes.

Hence the different effects, upon anima bodies, of the natural effluvia or aereal infuſions of certain vegetables, from thoſe of their diſtilled Waters. Damaſk roſes, in drying, impregnate the air of the room with their laxative virtue; and Red-roſe buds in like manner give out their aſtringency; virtues which never ariſe in diſtillation, but which common water and ſpirit extract readily by infuſion. The author above-quoted mentions ſome examples of this

* *Boerh.* proceſs i. *Sh.* tranſlat.

kind

commonly known to require any particular illuſtration. But it may be proper to obſerve, that as leſs of the oil ſeparates in the diſtillation of freſh than of dry vegetables, the Waters obtained from the former are proportionably ſtronger than thoſe from the latter: That the more compact kinds of vegetables require to be cut or bruiſed, and macerated or digeſted for ſome time in the Water previouſly to the diſtillation, in the ſame manner as for eſſential oils, with this difference however, that the common Salt, there made uſe of, is here leſs proper, a part of its acid ariſing with the Water: It has been cuſtomary to ſalt roſes for diſtillation, in order to preſerve them, without drying, till a ſufficient quantity could be collected: The Water diſtilled from ſuch roſes has often been found to retain ſo much of the acid of the Salt, as to turn milky with ſolution of Silver or Lead, and to corrode Iron. Some ſubſtances are advantageouſly fermented for a few days, with the addition of a little Sugar and Yeaſt, their ſmell and virtue being by this means more effectually extricated and communicated to the diſtilled liquor: Veronica, a plant of very little ſmell, and which if immediately committed to diſtillation gives over nothing conſiderable, yields, if ſlightly fermented, a Water that ſmells and taſtes ſtrongly of the herb. The quantity of Water made uſe of muſt be proportioned

kind, without ſeeming to have duly attended to their conſequences: For if the ſhade of the Walnut-tree makes the body coſtive, and the effluvia of Poppies procure ſleep; as theſe virtues are incapable of being elevated in diſtillation, does it not follow, that they muſt be communicated to the air upon ſome other principle?

With regard to the uſe of a Water-bath, though there are few vegetables that give over their flavour in that degree of heat, yet for thoſe which do, it is undoubtedly of great advantage: Fire ſenſibly injures, in proportion to its degree, the flavour of aromatic herbs, and thoſe which are moſt volatile ſuffer the moſt from it. Some tender flowers, as thoſe of Roſemary, have their fragrance impaired, by the bare mechanic action of watery or ſpiritous liquors, independently of heat, nearly in the ſame manner as it is by bruiſing them.

In diſtilling theſe kinds of ſubjects, I have varied the proceſs, by applying, inſtead of Water or ſpirit in their groſs form, only their vapours: The liquor being poured into the ſtill, a hair-cloth, ſtretched on an iron hoop, is let in above it, and on this the freſh unbruiſed flowers are lightly ſpread: The vapour into which the liquor is reſolved by the heat of a Water-bath, paſſing gently through the flowers, imbibes their fragrance unimpaired, and condenſes into a water or ſpirit greatly ſuperior to thoſe prepared in the common manner.

The foregoing obſervations point out a method of improving alſo the preparation of extracts. If infuſions of Mint, Balm, and ſundry other vegetables of the aromatic kind, be diſtilled by a gentle warmth in cloſe veſſels, little more than the watery menſtruum will ariſe, greateſt part of the flavour of the ſubject remaining behind in the extract. When the diſtillation is performed by a boiling heat, the whole of the flavour comes over with the Water; and when the inſpiſſation is performed in open veſſels, however gently, it is almoſt wholly abſorbed and carried off by the air. Our author himſelf ſeems to have been ſenſible of this in his experiments on tea; for in order to procure an extract from tea, poſſeſſing the admired flavour of the leaf, he finds it particularly neceſſary to inſpiſſate the infuſion without communication with the open air.

Thus we ſee, that by diſtilling many odoriferous vegetables in cloſe veſſels, we may obtain their fragrancy either in the Water that diſtills, or retain it in good meaſure in the extract, according as the degree of heat made uſe of is ſtrong or gentle; and that by evaporating them in open veſſels their fragrancy is in either caſe carried off by the air.

ESSENTIAL OILS.

tioned to the nature of the ſubject: Whatever quantity is added, the diſtillation muſt be continued no longer than while the liquor proves ſufficiently impregnated with the flavour of the ingredients. The virtues of many plants come over moſt plentifully in the firſt runnings; whilſt thoſe of others are more ſtrongly locked up, and ſcarce begin to ariſe till the diſtillation has been continued for ſome time. Where the plant is of ſuch a kind as to give but a weak impregnation to the diſtilled Water; we may render the liquor ſtronger by cohobation, that is, by drawing it over again from a freſh parcel of the ſubject (*s*).

SPIRIT

(*s*) *Waters made ſtronger by cohobation.*] This is another of the many proceſſes in which I have, on trial, been greatly diſappointed. Though ſome of the chemiſts affirm, that diſtilled Waters in general may be rendered, by repeated cohobations, of any aſſignable degree of ſtrength, and their virtues exalted without limitation †; I have not found that repetitions of theſe operations make any conſiderable addition to the ſtrength even of thoſe Waters, whoſe exaltation by this treatment has been particularly ſpecified.

The diſtilled Waters of Mint, Roſemary, and other aromatic herbs, being rediſtilled a number of times ſucceſſively from freſh parcels of the reſpective ſubjects; inſtead of being more and more exalted and improved, they were on every repetition more and more debaſed. Some of them indeed, by one cohobation, did ſeem to be rather mended, and ſometimes a ſecond did hardly any injury: But after this period, they all received an ungrateful taint from the repeated action of the fire, without gaining any more of the flavour of the ſubject than they had at firſt.

It is not by diſtillation, but by infuſion, that Water can be unlimitedly impregnated with any of the principles of plants. Water extracts by infuſion the gummy parts of vegetables; and it is a property of all gummy ſubſtances to diſſolve indefinitely in Water, that is, to unite with any proportion of it, ſmall or large, and render the liquor thicker and thicker as the quantity of gummy matter is increaſed. When Reſins or eſſential Oils are intimately combined with gums, as they are in moſt vegetables, theſe compounds unite alſo indefinitely with Water. Hence by macerating or infuſing, in the ſame Water, freſh parcels of aromatic herbs, the liquor takes up more and more of their ſoluble parts, till it grows too thick to be poured off, and the loſs of fluidity is the only bounds to the impregnation.

In diſtillation on the other hand, nothing ariſes with the Water but the eſſential Oil; and from pure eſſential Oils this fluid extracts only a limited quantity. Salts are in this reſpect ſomewhat analogous to Oils: When a certain quantity of Salt is diſſolved in Water, the liquor, though thin and fluid as at firſt, will take up no more: By the application of heat, it may be made to diſſolve a larger quantity than in the cold, but all that is ſo diſſolved will be ſeparated and thrown out again upon an abatement of the heat. So, when eſſential Oils are coagitated with Water by a boiling heat, and elevated along with it in form of vapour; the Water, condenſing again, keeps a part of the Oil diſſolved, and throws out the reſt. The Water is now ſaturated, and it is in vain to endeavour, by any repetitions of the diſtillation, to make it imbibe more.

Hence the uſe of employing the Water which ariſes in the diſtillation of eſſential Oils, for ſubſequent diſtillations of the Oil of the ſame ſubject: Being ſaturated with Oil in the firſt diſtillation, it diſſolves none of that which ariſes with it in the others; and thus the produce of Oil proves proportionably larger than if freſh Water was taken.

It follows from this account, that there is one caſe, in which cohobation may be of ſome ſervice; that when the Water is not fully ſaturated in the firſt diſtillation, it may be made to imbibe more by a repetition of

† *Id.* proceſs xvi.

it

SPIRIT of Wine, conſidered as a vehicle for the volatile virtues of vegetables, has one advantage above Water; keeping the whole of the eſſential oil, that ariſes with it, diſſolved. Thus if Citron-peel be diſtilled with rectified ſpirit, the oil will come over diſſolved in the menſtruum into an uniform tranſparent liquor, poſſeſſing in a high degree the fine flavour of the peel: On diluting this ſpirit with Water, the mixture immediately becomes milky, the oil ſeparates, and is gradually collected upon the ſurface. This is an uſeful method of obtaining ſome of the more volatile oils. ESSENTIAL OILS. Diſtilled ſpirits.

Spirit of Wine cannot be made to receive ſo great a degree of heat as Water: It boils and diſtils much ſooner, and no increaſe of fire will make either of them hotter after they have begun to boil. Hence the oils, obtained in the above method by means of ſpirit, prove more fragrant, as having undergone leſs heat, than thoſe diſtilled with Water. But hence alſo there are many oils which this liquor is incapable of elevating: For though they are all volatile in the heat of boiling Water, there are few which ariſe in the heat of boiling ſpirit.

The greater number of odorous vegetables give over nothing conſiderable to ſpirit. If rectified Spirit of Wine be diſtilled over from Rhodium wood, Cinnamon, Nutmegs, and even from ſome of the more fragrant flowers, as roſes and lilies, it will ſcarcely diſcover any ſmell or taſte of the ſubjects; whilſt Water brings over the whole of their flavour. The only method of obtaining a Spirit impregnated with the volatile oils of theſe kinds of ſubſtances is, to diſſolve ſome of the oil itſelf in pure Spirit of Wine, or to uſe in the diſtillation a mixture of ſpirit and Water.

III. CAMPHORS.

CAMPHORS are extracted by diſtillation with Water, nearly in the ſame manner as eſſential oils. From ſome vegetables, the Camphor ariſes at firſt in its proper ſolid form: from others, only a fluid oil diſtils, from which the Camphor concretes upon long ſtanding. It is chiefly from plants produced in the warmer climates, that Camphors are obtainable; as the tree called, from its abounding with this concrete, *Arbor camphorifera*, the roots of the Cinnamon-tree, Zedoary, Schœnanthus, Cardamon-ſeeds, the Oriental mint, Abrotanum, Milfoil, Daiſy, Juniper, Roſemary, Sage, Camphorata, Lavender, Hyſſop, Clary, Maudlin, Marjoram, *&c.* though I have likewiſe extracted a true Camphor from the common European thyme. CAMPHORS.

IV. EXPRESSED OILS.

GROSS Oil abounds chiefly in unctuous ſeeds and the kernels of fruits, as Linſeed, Rape-ſeed, Poppy-ſeeds, Almonds, Nuts, Peach-kernels, *&c.* Theſe or other like ſubſtances, in order to the extraction of their expreſſible Oil, EXPRESSED OILS. Method of obtaining them.

it. But ſurely it is more adviſable, to uſe the plant, in ſuch quantity as may give a ſufficient impregnation at once, than to endanger debaſing the flavour which the liquor has once received by communicating more.

EXPRESSED OILS. Oil, are pounded or ground in mills into a ſmooth maſs, then incloſed in a canvas bag, and committed to a ſtrong preſs, by which the Oil is plentifully forced out, amounting ſometimes to above half the weight of the ſubject. Some previouſly warm the plates of the preſs, and even heat the pounded maſs itſelf in a kettle, keeping it conſtantly ſtirring with a wooden ſpatula, to prevent its burning. This facilitates the ſeparation of the Oil, and if the heat is ſmall, does it no injury: In winter, or if the ſubject is moiſt, a gentle warmth is particularly neceſſary, in one caſe to render the Oil fluid, in the other to diſſipate the humidity. Some have been accuſtomed both to warm and to moiſten the maſs, and thus procure a ſomewhat larger yield of Oil: This practice is nevertheleſs highly to be blamed, as the Oil thus obtained, quickly ſpoils and becomes rancid.

Differences from one another. All the expreſſed Oils agree in their general qualities, whatever ſubſtance they were drawn from. There are however ſome particular differences conſiderable enough to deſerve notice: Thus the workmen find that ſome of theſe Oils, as that of Linſeed, anſwer better for varniſhes than the purer and finer ones of Olives or Almonds. Moſt of theſe Oils, however carefully drawn, become rancid and acrimonious upon long keeping; but there are ſome, particularly the Oil of Ben-nuts, which continue unaltered for ſeveral years: Hence the uſe of this Oil as the baſis of perfumes. Moſt of them coagulate in winter into a thick, white, butyraceous maſs; but ſome, as thoſe of Linſeed and Rape-ſeed, remain fluid. They are all leſs readily inflammable than eſſential Oils, and conſume more ſlowly: A pound of Oil Olive, for inſtance, continues burning as long as four or five pounds of Oil of Turpentine.

Seat of expreſſible and eſſential Oils in ſeeds. Some ſubſtances contain both an expreſſible and eſſential Oil, as the ſeeds of umbelliferous plants; thoſe of Aniſe for inſtance. In this caſe, the Oil obtained by expreſſion generally brings forth with it a part of the eſſential Oil, and thus proves impregnated with the flavour of the ſeeds: The Oils expreſſed from other vegetable matters have no particular taſte or ſmell: The expreſſed Oil of the acrimonious Muſtard-ſeed is perfectly void of acrimony. In what parts of thoſe ſeeds the two Oils reſide, was little known or examined, till the younger Geoffroy of Paris, in diſtilling ſome Coriander-ſeeds, having employed, perhaps accidentally, almoſt mere huſks, diſcovered the true ſeat of the eſſential Oil: Experiments on other ſeeds alſo, of that claſs, have evinced, that the eſſential reſides ſolely and wholly in the outer ſkin, and the expreſſible Oil in the kernel of the ſeed. This obſervation is not however to be extended beyond the ſeeds of umbelliferous plants: Of Cardamom-ſeeds, it is the kernel that contains the eſſential Oil and the medicinal activity.

V. ESSENTIAL SALTS.

ESSENTIAL SALTS. ESSENTIAL or native Salts, ſo called in diſtinction from the fixed alcaline Salts produced from vegetables by art, are obtained chiefly from plants of the acid kind, as Sorrel. A quantity of the leaves is gathered in the ſpring, pounded in a ſtone mortar with a wooden peſtle, and the juice preſſed out into tinned veſſels: Some warm water may be added to the remaining maſs, and the expreſ-

Method of preparing them.

expreſſion repeated, that the ſaline matter may be more perfectly extracted. The liquor ſuffered to ſtand for a day or two, depoſites a thick feculence: Being then poured off clear, and paſſed through a ſtrainer, it is ſet to evaporate in a cut glaſs body placed in a gentle ſand heat till about one half is waſted, or till it is reduced nearly to the conſiſtence of a ſyrup; after which it is removed into a cellar, and ſuffered to ſtand till the Salt has cryſtallized. Some continue the inſpiſſation further, put the matter into flat earthen diſhes, and pour ſome Oil on the ſurface. Others expedite the cryſtallization, by ſetting the liquor, duly depurated and evaporated, not in a cold cellar, but in a warm room, where it is left to ſhoot in the ſame manner as Sugar Candy. The cryſtals are to be nimbly rinſed with water, and dried upon ſpongy paper in a gentle warmth. Several of the cryſtals generally prove browniſh coloured and foul: If required to be pure and white, they are diſſolved in water, the ſolution filtered, and ſet to ſhoot a ſecond time. The ſaline matter remaining after the cryſtallization may be diluted with the water in which the cryſtals were waſhed, and after due purification, ſet to cryſtallize again as at firſt. ESSENTIAL SALTS.

This tedious proceſs is rarely performed; and the nature of the Salts, obtainable by it from different vegetables, has been little examined. The Salts of acid plants are ſimilar in moſt reſpects to Tartar, though not as ſome have ſuppoſed, perfectly the ſame: The Salt of Sorrel is manifeſtly more acid, and diſſolves in half the quantity of water that Tartar requires. With regard to the preparation of them, much depends upon the liquor being duly purified from the groſs oily matter, which impedes the ſeparation and concretion of the Salt. The ſweet eſſential Salt of the Sugar Cane cannot be procured in its concrete ſaline ſtate, without the addition of Lime-water during the inſpiſſation, to promote its ſeparation from the unctuous matter (*s*).

It

(*s*) *Eſſential Salts.*] Stahl obſerves that the tedioufneſs of the cryſtallization is in great meaſure owing to the viſcid oily matter of the juice, which entangles and prevents the coaleſcence of the ſaline particles: Hence he endeavours to improve the proceſs, by firſt extracting the oily and reſinous matter by Spirit of Wine, and afterwards the ſaline by water. He directs Wormwood, Brook-lime, Pellitory, Herb-mercury, Sopewort, or other plants of the like kind, to be dried quick in a ſhady place, then cut ſmall, and digeſted in freſh parcels of rectified ſpirit, till the menſtruum ceaſes to extract any colour. The plant thus freed from its Oil and Reſin, is to be gently exſiccated and boiled in water, the decoction filtered, evaporated to a due conſiſtence, and ſet by in a cool place to cryſtallize. The cryſtals, he ſays, are found upon examination to be of the nitrous kind.

Spieſſius on the other hand (in the ſecond continuation of the *Miſcellanea Berolinenſia*) ſeeks for the eſſential Salt in the ſpirituous tincture. Wormwood, Carduus benedictus, or other like plants, gently dried in the ſhade, are digeſted in Spirit of Wine, with a ſoft heat, till the liquor is tinged green, the tincture put into a glaſs cucurbit, and diſtilled with the heat of a water-bath, till ſo much of the ſpirit is come over, that the reſiduum may be of the conſiſtence of honey. The whole being now ſuffered to remain unmoved till grown perfectly cold, he finds beautiful pyramidal cryſtals ſhot from the ſides of the cucurbit towards its center.

The laſt mentioned author relates likewiſe that having made an eſſence (that is a ſaturated tincture) of Elecampane roots with Spirit of Wine, and kept it unmoved for a year, he found a great number of cryſtals ſhot from the bottom upwards of the thickneſs of a quill, and about an inch long. He ſays the cryſtals obtained by this method are of the nitrous kind, but of a more ſubtile

taſte

ESSENTIAL SALTS. Juices.

It may be proper to obſerve, that though juicy ſaline vegetables, whether of the acid or the ſweet kind, give out their ſaline matter uninjured upon expreſſion; yet there are many, particularly aromatic herbs and flowers, whoſe juices retain nothing of their peculiar ſmell or taſte, and whoſe flavour is abſolutely deſtroyed by the action of the preſs. Squeeze betwixt the fingers a Violet or a Jaſmin flower, and all their fragrance is in an inſtant loſt.

PRINCIPLES. Native principles illuſtrated.

THUS we have ſeen, that the medicinal and other intrinſic powers of vegetables reſide in a few ſubſtances, which chemiſtry, by the moſt obvious and ſimple of her operations, extracts, ſeparates, purifies, and preſerves, unaltered in their quality, but greatly increaſed in activity by the rejection of the parts which are unactive: That ſome of theſe ſubſtances, as thoſe in which bitterneſs and aſtringency conſiſt, are diſſolved by boiling water, and left, upon evaporating the liquid, concentrated into an extract, whilſt that matter on the other hand, in which odours are lodged, exhales along with the water, and may often be collected in the form of an extremely active Oil: That hence, when bitter plants, for inſtance, are accompanied with an ill ſmell, we can procure in the extract, the ſimple bitterneſs diveſted of that offenſive part; and that in like manner, when fragrant ſubſtances are accompanied with a bitter nauſeous taſte, we procure the ſimple fragrance concentrated in the Oil: That by rectified Spirit of Wine, we frequently obtain the entire virtue of the plant, both fixed and volatile, combined into one extract.

Theſe ſubſtances we call the native principles of vegetables: *Native*, becauſe they naturally exiſt in the ſubject, art doing nothing more than barely to extract them: *Principles*, not as being ſimple bodies, for they are all compounded; but as it is by theſe that one plant differs from another, and that every plant exerts its ſpecific powers; and as we cannot further reſolve them, without totally deſtroying their peculiar qualities, and converting them into ſubſtances, as different from any thing that exiſted in the original vegetable, as they are from one another.

Artificial principles.

Vegetables diſtilled in cloſe veſſels by a ſtrong fire, yield an acid or an alcaline liquor or both, and an acrimonious, fetid, empyreumatic Oil: In the bottom of the retort remains a black coal, which burnt in the open air changes into

taſte than common Nitre, impreſſing only an agreeable coolneſs upon the tongue.

The two foregoing proceſſes agree but ill with one another: How far they are adequate to the purpoſes intended by them cannot be determined without further experiments. It is certain that Spirit of Wine diſſolves the ſubtile Oils and the Reſins of vegetables, which prove a great impediment to the cryſtallization of Salts; whence it ſhould ſeem, that the Salt might be afterwards extracted by water from the reſiduum, to much better advantage than from the plant at firſt. But it is certain alſo, that this menſtruum diſſolves many of the native vegetable Salts themſelves; and that if the tincture is ſaturated, or duly evaporated, the Salt ſeparates, leaving the oily and reſinous matter diſſolved. Thus Manna diſſolves totally in rectified ſpirit, and however foul before, is recovered white as ſnow, its impurities being left in the menſtruum: Thus tinctures of Celeri, Beet-roots, and other plants of the ſweet kind, made in rectified Spirit of Wine, depoſite on ſtanding a Saccharine Salt; the ſpirit, though it diſſolves the ſaline part by the aſſiſtance of heat, gradually parting with it in the cold, whilſt the other matter it had extracted remains diſſolved.

into white aſhes: From theſe is obtained, by elixation with water, a portion of fixed alcaline Salt; a few vegetables excepted, which inſtead of a fixed alcali in the aſhes, afford a volatile one in the diſtillation. PRINCIPLES.

Theſe products have no reſemblance in taſte, ſmell, or any other ſenſible property, to the original ſubject: Nor are the Spirits, the Oils, the fixed or the volatile Salts produced from one vegetable, to be diſtinguiſhed from thoſe which are afforded by another. Yet ſuch has been the infatuation of the chemiſts, that in examining particular plants, they have hitherto fondly purſued this deſtructive reſolution, and aſſigned, for the natural principles of the plant, theſe artificial products which had no exiſtence in it.

We ſhall now proceed to examine vegetables ſingly, according to the ſyſtem of native principles here laid down, chuſing from the almoſt endleſs variety of ſubjects, which the vegetable kingdom affords, ſome of the principal that have been employed for medicinal, dietetic or mechanic uſes. Theſe may be ranged in two general diviſions; the juices, which iſſue ſpontaneouſly, or are extracted or purified by the aſſiſtance of art; and plants or their parts in ſubſtance.

SECT. II.

Of VEGETABLE JUICES.

CLASS I.

GUMS.

GUMS.

THE ſtrongeſt Gum is that called, from the Tragacanth or Goats-thorn-tree which produces it, Gum Tragacanth, and corruptly Dragant. The Goats-thorn is a prickly, papilionaceous-flowered tree, growing in the iſland Candy and other parts of Aſia, near Aleppo in Syria, in Cilicia, on the ſea-coaſts about Marſeilles, *&c.* In Candy, the gummy juice begins to exude about the latter end of June: Tournefort has given a copper-plate repreſenting its ſucceſſive protruſion, and the manner of its concretion: It proves more or leſs pure, of a whiter or darker colour, according to the weather after its exudation, and the accidental admixture of duſt. Tragacanth.

The beſt Gum Tragacanth is in white, light, ſmooth, tranſparent, vermicular tears or ſtriæ, of a ſweetiſh taſte, without any ſmell. A yellowiſh or browniſh colour, though an imperfection in the drug, is not a mark of its being impure: The very whiteſt Gum becomes dark-coloured, barely by being diſſolved in pure diſtilled water, and exſiccated again by a gentle warmth: Some report, that it ſuffers the ſame change on being long kept. It diſſolves totally in water: Spirit of Wine extracts only about half a ſcruple out of an ounce. It gives over nothing in diſtillation either to water or to ſpirit, both the liquors ariſing unchanged. It is difficultly reducible into powder, unleſs it be tho-

GUMS. roughly dried, and the mortar heated; or in winter, when ſtrong froſts have rendered the Gum hard and brittle.

Gum Tragacanth is made uſe of for faſtening down dry ſpecimens of plants upon paper, in making artificial flowers, in dying ſilks, and for the other more curious mechanic purpoſes, where a ſtrong and a fine Gum is required, whether for conglutinating, ſtiffening, or brightening. In medicine, it is employed for giving tenacity to powders, ſo as to fit them for being made into troches and other like forms: In electaries it is improper, as it renders them too ſlimy upon keeping. Tough coheſive ſubſtances, as Agaric and Colocynth, are made pulverable by beating them with a mucilage of Gum Tragacanth, and then drying the maſs. With regard to the virtues of this and other Gums, they ſoften and thicken acrimonious thin juices, and hence their uſe in fluxes, and in ſome kinds of coughs and other diſorders of the breaſt: In coughs where thick phlegm abounds, they are rather hurtful than beneficial (*t*).

CLASS II.

RESINS.

RESINS. Balſams. OF the reſinous juices of vegetables, there are ſome which exude ſlowly, and after their exudation ſoon concrete upon the tree into ſolid tears or maſſes, of various figures and magnitudes. Others iſſue more copiouſly, retain their fluidity longer, and are commonly brought to us in their liquid ſtate, under the name of balſams (*u*). Balſams

(*t*) *Gum Tragacanth.*] This differs from all the other gummy ſubſtances hitherto known, in giving a thick conſiſtence to a much larger quantity of water, and being much more difficultly, or rather not at all perfectly diſſoluble. Put into water, it ſlowly imbibes a large quantity of the liquid, ſwells into a large volume, and forms a ſoft but not fluid Mucilage. If the quantity of water is more than the Gum can imbibe, the Mucilage forms an irregular maſs, which does not mingle with the reſt of the water on ſtanding for many days, but unites or diſſolves by ſlight agitation: The ſolution has a wheyiſh or turbid appearance; and on ſtanding for a day or two, the Mucilage ſubſides again, the limpid water on the ſurface retaining little of the Gum.

Gum Arabic, Gum Senegal, and the Gums of the European Plum and Cherry-trees, ſeem to be but little different from one another: The Senegal is ſuppoſed to be the ſtrongeſt, and the Arabic the fineſt Gum. Gum Senegal, brought from the iſland of that name on the coaſt of Africa, commonly ſupplies the place of the Arabic in the ſhops, and is the ſort chiefly employed by the callico-printers, and in other buſineſſes where Gums are made uſe of: It is generally in larger maſſes than the other, and of a darker yellowiſh or browniſh colour. All theſe are nearly pure Gums: They readily and perfectly diſſolve in water into a limpid liquor, and do not ſeparate from it upon ſtanding: On inſpiſſating the ſolutions, the exſiccated Gums prove, like Gum Tragacanth treated in the ſame manner, conſiderably darker coloured than at firſt.

It is obſervable that Gum Arabic and Gum Tragacanth are very little diſpoſed to unite with one another. When diſſolved in water and mixed together, the Gum Tragacanth ſeparates in a much ſhorter time than when diſſolved by itſelf; and this whether the ſolutions be thick, or diluted largely with water.

(*u*) *Reſins.*] It is ſuppoſed, and with great probability, that Balſams and Reſins, are no other than vegetable Oils, of the ſubtile or the groſs kind, ſomewhat altered by the intimate admixture of a vegetable acid and perhaps

Balſams diſſolve, like the ſolid Reſins, in rectified Spirit of Wine, moſt readily in ſuch as is impregnated with fixed alcaline Salt. They mingle with all eſſential Oils, though with one more readily than with another. By trituration with Almonds, Piſtachio nuts, Hazel nuts, and other like unctuous farinaceous kernels, they become miſcible with water into an emulſion or milky liquor. Yolk of eggs alſo renders them ſoluble in water; and Sugar ſtill more elegantly (*x*). In diſtillation with water they yield, ſome a large, and others a ſmall quantity of eſſential Oil, a ſolid brittle Reſin remaining behind in the ſtill. RESINS.

I. OPOBALSAM.

THE moſt precious of the Balſams is that commonly called OPOBALSAM, or Balm of Gilead, *Opabalſamum*, *Balſamelæon*, *Balſamum verum*, *Album*, *Ægyptiacum*, *Judaicum*, *Syriacum*, *Gileadenſe*, *è Mecca*, &c. This is the produce of certain trees, which grew formerly in the valley of Jericho, but after the conqueſt of the Holy Land by the Turks, were removed to Grand Cairo, where the Balſam plantation is ſaid to be now guarded by Janiſſaries, and the reſinous juice collected for the Sultan only.

We are not to imagine, that what is ſold by the druggiſts under the name of this balſam, at no very great price, is the true Egyptian ſort: It is either the native juice of another kind of tree, or what is more probable, a compoſition of Balſam of Copaiba with diſtilled Oils, *&c.* Hence we meet with Opobalſams very different from one another, or agreeing only in external appearance. The

perhaps an over-proportion of earthy matter, or deprived of their more volatile and watery parts.

Some of the chemical writers, particularly Mr. Macquer, imagine mineral Bitumens alſo to be of the ſame origin; to be no other than vegetable Reſins, ſomewhat altered by the admixture of mineral acids in the earth. This opinion, though it appears ſpecious from the conſiderations brought in ſupport of it, is built perhaps upon too ſlight foundations.

Mineral Bitumens are very different in their qualities from vegetable Reſins; and in the mineral kingdom we find a fluid Oil, very different from vegetable Oils. The mineral Oil is changed by mineral acids into a ſubſtance greatly reſembling Bitumen; and the vegetable Oils are changed by the ſame acids into ſubſtances greatly reſembling the natural Reſins. From Bitumens we gain by diſtillation the mineral Oil, and from Reſins the vegetable Oil, diſtinct in their qualities as at firſt. Vegetable Oils and Reſins have been treated with all the known mineral acids, but have never yielded any thing ſimilar to the mineral Bitumens. It ſeems therefore, as if the oily products of the two kingdoms were ſpecifically and eſſentially different. The laws of chemical enquiries, at leaſt, demand that we do not look upon them any otherwiſe, till we are able to produce from one a ſubſtance ſimilar to the other. When this ſhall be done, and not before, the preſumptions that nature effects the ſame change in the bowels of the earth, will be of ſome weight.

(*x*) *Balſams rendered miſcible with water by Sugar*, &c.] Balſams, like eſſential Oils, are ſtill more elegantly diſſolved in water by the intervention of Gums and Mucilages; and the ſolutions obtained by the means of theſe are likewiſe the moſt permanent. Gum is the medium employed by nature herſelf for uniting the oily, reſinous and balſamic juices of vegetables with the watery; the medium, which enables water to extract by infuſion, the flavour of aromatic herbs. Gum Tragacanth renders Oils and Balſams miſcible with water, as well as the more ſoluble Gums; but the ſolutions made by the former are leſs permanent than thoſe made by the latter.

OPOBALSAM. The only ſpecimen of the genuine Egyptian Balſam that I have ever ſeen, was one in the Royal Apotheca at Dreſden, received by King Auguſtus among other preſents, from the Grand Signior himſelf. An Arabian Balſam, left in our own repoſitory by my predeceſſor Gundelſheim, who had probably procured it in Arabia or at Conſtantinople, where he travelled with Tournefort, comes the neareſt to the above.

The true Balſam is of a pale yellowiſh colour, clear and tranſparent, about the conſiſtence of Venice Turpentine, of a ſtrong, penetrating, agreeable, aromatic ſmell, and a ſlightly bitteriſh pungent taſte: By age it becomes yellower, browner and thicker, loſing by degrees, like eſſential Oils, ſome of its finer and more ſubtile parts. To ſpread, when dropt into water, all over the ſurface, and to form a fine, thin, rainbow-coloured cuticle, ſo tenacious that it may be taken up entire by the point of a needle, were formerly held infallible criteria of the genuine Opobalſam. I have obſerved, however, that other Balſams, when of a certain degree of conſiſtence, exhibit theſe phænomena equally with the Egyptian (*y*).

II. BALSAM OF TOLU. BALSAM OF TOLU is commonly of a thicker conſiſtence than the foregoing, and more of a browniſh colour: When freſh, it has an exceeding pleaſant ſmell, ſomewhat reſembling that of Citrons. It is ſaid to be the produce

(*y*) *Balſam of Gilead.*] This Balſam, according to Proſper Alpinus, is obtained from a ſmall Evergreen-tree or Shrub, about the ſize of the Privet or *Cytiſus*, with flexible branches and a few leaves, which reſemble thoſe of Rue or rather of the Lentiſk-tree, ſet in pairs along a middle rib, with an odd one at the end. The branches are covered with two membranous thin barks, the outermoſt of a reddiſh-brown colour, the inner greeniſh; the woody part is white. The flowers are of a purpliſh white colour, in ſhape like thoſe of Acacia: The fruit is a ſmall reddiſh black berry, containing yellow ſeeds.

The wood is ſaid to be inodorous, the bark fragrant and aromatic, the flowers highly odoriferous; the berries to be odorous, acrid, and bitter, and to yield a yellow liquor of the appearance of honey. The branches and dry berries have been ſometimes brought into Europe, and kept in the ſhops for medicinal uſe, the former under the name of *Xylobalſamum*, the latter of *Carpobalſamum:* Whatever ſmell or taſte theſe ſubſtances may have when freſh, they have little of either as they come to us.

The precious Balſam exudes in very ſmall quantity, from ſlight inciſions made in the bark. According to the author above-mentioned, it is at firſt white, of a very ſtrong penetrating ſmell, of the Turpentine kind, but ſweeter and more fragrant, and of a bitter, acrid, aſtringent taſte. It looks in part turbid and thick, like the Oil newly expreſſed from Olives: Afterwards it grows extremely thin, limpid and light; its colour changes to a greeniſh, then to a Gold yellow, and by long keeping, to that of honey; it now grows thick like Turpentine, and loſes much of its fragrance.

Inferior ſorts of Balſam are ſaid to be obtained by boiling the branches in water: When the liquor begins to boil, a thin Oil ariſes to the ſurface, and on continuing the coction a groſſer and thicker one.

Mr. Geoffroy obſerves, that a ſolution of Balſam of Gilead made in Spirit of Wine, turns milky on being poured into water, but does not depoſite any Precipitate; and that this mixture is uſed in France as a coſmetic. He ſays an equal quantity of Oil of Almonds is previouſly mixed with the Balſam; but this ingredient can be of no uſe, as it totally ſeparates and falls to the bottom whilſt the Balſam diſſolves in the ſpirit.

duce of New Spain, and to exude in very hot weather, from incisions made in the bark of a small tree of the Fir kind, called Tolu (z). BALSAM OF TOLU.

III. BALSAM OF COPAIBA.

BALSAM OF COPAIBA, *Cophahu*, *Copaif*, *Campaif*, *Copalyva*, or *Gamelo*, is obtained from a tree of the same name, growing in the Brazils, near the Rio de Janeiro, in Fernambuco, and St. Vincent's. It is of a pale yellowish colour, and thin consistence. It is observable, that on mixing this juice with the watery Spirit of Sal ammoniac made by Quick-lime, a frothing, or effervescence as it is called, ensues, stronger and of longer continuance than that produced by the same spirit with any other natural Balsam: By this mark we may distinguish the genuine Copaiba from the thin Resin of the Turpentine or Fir-tree which is frequently mixed with, or vended for it (a). This Balsam is at present of very common use, or misuse, as a medicine.

IV. BALSAM OF PERU.

BALSAM OF PERU is obtained from certain trees of Peru and Mexico, differing somewhat from one another in appearance, and somewhat also in the quality of their juices. The Balsam-tree described by Piso, under the name of *Cabureiba*, has small leaves like those of the Myrtle, and a thick ash-coloured bark, covered with a very thin red one: Under this is lodged a yellowish Balsam, that impregnates the whole substance of the bark, which by age becomes more and more fragrant. Hernandez describes the Mexican Balsam-tree, as having leaves like those of the Almond, and a thick bark like Cork, from which the Balsam flows upon wounding the outer thin rind. Plukenet mentions a tree of the same kind in Virginia, by the name of *Arbor Virginiana*, *Pisaminis folio*, *Baccata*, *Benzoinum redolens*.

There

(z) *Tolu.*] Of the tree which produces this balsam we have no particular description. Linnæus has given its generical characters, under the name of *Toluifera*; and in these it differs greatly from the Firs and Pines, to which it is commonly resembled. The balsam is one of the most elegant and grateful of the substances of this class, and does not lose much of its fragrance when by age it grows consistent. It yields very little essential Oil in distillation, but impregnates the distilled water strongly with its flavour. By dissolving in this water, in a gentle warmth, a proper quantity of fine Sugar, we obtain a balsamic syrup greatly superior to that made in the common manner with a decoction of the balsam. I have sometimes obtained from this balsam a saline matter, similar to the flowers of Benzoine.

(a) *Copaiba.*] It is observable also of this balsam, that on being distilled in a retort, it gives over towards the end of the operation, an Oil of a fine blue colour, preceded by a limpid, and a yellowish or browniſh one. Distilled with water, it yields a large quantity of a limpid essential Oil; from sixteen ounces I have gained eight.

The Copaiba-tree is one of the large forest trees of Brazil and some other parts of America: Mr. Ray calls it *Arbor Balsamifera Brazilienſis fructu monoſpermo*. The leaves are roundish or oval, the flowers pentapetalous, the fruit a pod containing a kernel like a filberd. The wood is of a deep red colour, and great hardness; and hence is employed in ornamental mechanic works, and is said to be used also in dying. The balsam is extracted by making deep incisions in the trunk of the tree, in the middle of the summer heats; if this operation is performed too early, no juice exudes, in which case the wounds are for a time closed up. It is said that twelve pounds of balsam issue from one tree in a few hours; but that after once bleeding, it never affords more.

BALSAM of PERU. There are three ſorts of Balſam of Peru: (1.) A colourleſs or pale yellowiſh, called *white*, in appearance ſomewhat reſembling the Opobalſam, and like it of a ſtrong ſmell: This is the native juice, collected and preſerved in the ſame ſtate wherein it iſſues from the tree. Among us, it is rarely or never met with, (2.) A *dry* Balſam, or the foregoing inſpiſſated by the ſun's heat, in calabaſhes or gourd-ſhells, in which it is ſometimes brought into Europe: This has ſomewhat of a reddiſh colour, and ſtill ſmells very agreeably. (3.) The *common* or *black* Peruvian Balſam of the ſhops. This ſort is artificially extracted from the bark, branches and leaves of the tree by cutting them in pieces, and boiling them in water: The Balſam is ſaid to ſeparate, and ariſe to the ſurface, from whence it is taken off (*b*). A portion of the gummy or other matter of the plant which the water extracts, is retained by the Balſam, and falls to the bottom upon diſſolving it in Spirit of Wine. Pomet and others report, that this Balſam is counterfeited or ſophiſticated with mixtures of expreſſed Oils and other ſubſtances: But happily the Balſam of Peru will not in any degree mingle with thoſe Oils; in which reſpect it differs from almoſt all the other reſinous bodies.

This Balſam is of a thick conſiſtence, like honey; of a dark black colour in the maſs, but when ſpread thin of a clear reddiſh or yellowiſh brown, of an agreeable ſtrong ſmell, ſomewhat approaching to that of a mixture of Benzoine and Storax, and of a bitteriſh pungent taſte, eaſily inflammable, not in the leaſt miſcible with water, nor rendered turbid or white on being agitated with that fluid. It becomes ſoluble in water, like the other Balſams, by the mediation of yolk of eggs or of Sugar: When diſſolved by the latter, it ſoon ſeparates from the water, whilſt the former keeps it much longer ſuſpended.

In diſtillation with water, it yields a ſmall quantity of a fragrant eſſential Oil: Hoffman prepares alſo a grateful ſpirit, by drawing over Spirit of Roſes from a mixture of the Balſam with half its weight of Salt of Tartar, divided by moiſt ſand. Diſtilled in a retort with an open fire, it affords a Butter like that of Benzoine, and oftentimes a conſiderable quantity even of concrete ſaline flowers, ſimilar to thoſe procured from that Reſin: Different ſorts of the Balſam exhibit ſome differences in this operation, but I have never met with one that did not yield both the Butter and Flowers.

V. TURPENTINES. TURPENTINES are extracted from different kinds of trees in Europe. The true Terebinth-tree (*Terebinthus vulgaris C. B.*) is found in Spain and the ſouthern parts of France, as well as in the iſland Chio and the Indies. It is a middling ſized Evergreen-tree, with leaves like thoſe of the Bay, bearing purpliſh imperfect flowers, and on ſeparate pedicles, hard unctuous berries like thoſe of the Juniper buſh. It is extremely reſinous, and unleſs the Reſin is diſcharged,

Chian.

(*b*) *Balſam ariſes to the ſurface.*] This is the common account of the preparation of the Balſam of Peru, firſt publiſhed by Cluſius, and copied by moſt of the later writers. It is not however very conſiſtent with the gravity of this balſam; for the ſeveral ſpecimens I have examined, inſtead of ſwimming, were found to ſink both in pure water, and in moderately ſtrong vegetable decoctions and infuſions. In cold water, the drops fall to the bottom entire: In boiling hot water, a ſmall portion ſeparates, and forms a fine thin pellicle upon the ſurface.

charged, decays, produces fungous excreſcences, ſwells, burſts and dies; the prevention of which conſiſts wholly in plentiful bleeding both in the trunk and the larger branches. The juice is the Chio or Cyprus Turpentine of the ſhops: This ſort, as we now and then meet with it (for among us it is very rare) is of a quite thick conſiſtence, of a greeniſh-white colour, clear and tranſparent, of ſcarcely any taſte, and but little ſmell. TURPENTINE.

The Larch-tree (*Larix folio deciduo conifera J. B.*) plentiful in ſome places of France, particularly in Dauphiny, as alſo in Auſtria, Tyrol, Italy, Spain, &c. is no leſs reſinous than the Terebinth, and no leſs ſubject to ſwell and burſt unleſs its Reſin is evacuated. The young trees yield a thin limpid juice, greatly reſembling Balſam of Copaiba, called by the French *Bijon*; the older, a yellower and thicker one. What is called Venice Turpentine is no other than this juice, brought chiefly from Dauphiny, about the conſiſtence of a thick Syrup or Honey, tranſparent, of a pale yellowiſh, a yellow, browniſh, or reddiſh-brown colour according to its age, of a bitteriſh taſte, and a ſtrong, not agreeable ſmell. What the Venice Turpentine originally was, is now unknown. It is ſuppoſed that Venice was formerly the mart for the Turpentine collected from the Terebinth-tree in the iſland Cyprus; and that the thinner juice was called Venetian, and ſuch as had grown thick Cyprian. At preſent we receive no Turpentine from Venice or from Cyprus. Venice.

The Straſburgh Turpentine, *Terebinthina Argentoratenſis*, ſo called from the place of its production, is extracted from the Silver-fir, the *Abies conis ſurſum ſpectantibus ſive mas* of Caſpar Bauhine (*c*). The common Turpentine is prepared from different ſorts of the pine. This laſt is frequently ſophiſticated or counterfeited with mixtures of different reſinous ſubſtances, ſolid and liquid: It is quite thick, white, and untranſparent. Straſburgh. Common.

All the Turpentines yield a conſiderable proportion of Oil. From ſixteen ounces of Venice Turpentine (the ſort principally employed for medicinal purpoſes) were obtained by diſtillation with water, four ounces and three drams of eſſential Oil. The ſame quantity diſtilled without addition, in the heat of a water-bath, gave but two ounces and a half; and from the reſiduum, treated with water, only an ounce could be obtained; ſo that by this method the yield of Oil is near an ounce leſs than when the Turpentine is diſtilled directly with water. The water remaining in the ſtill is found to have extracted little or nothing from the Turpentine: On the contrary, the Turpentine imbibes a part of the water, the reſiduum and the Oil amounting together to a full ounce more upon the pound than the quantity of the juice employed. When Turpentine is diſtilled or boiled with water till it becomes ſolid, it appears yelloweſh; when the proceſs is further continued, of a reddiſh-brown colour: In the firſt ſtate, it is called boiled Turpentine, in the latter Colophony. Oil of Turpentine. Common Reſin.

On diſtilling ſixteen ounces in a retort, with an open fire increaſed by degrees, we obtain firſt four ounces of a limpid colourleſs Oil, then two ounces and

(*c*) *Turpentine from the Firs.*] Some of the exotic Firs afford Balſams or Reſins ſuperior to thoſe obtained from the European ones, as particularly that called Balm-of-Gilead Fir, which is now naturalized to our own climate. A large quantity of an elegant reſinous juice may be collected from the cones of this tree: The leaves alſo emit, when rubbed, a fragrant ſmell, and yield with rectified ſpirit, an agreeable reſinous extract.

TURPENTINE. and two drams of a yellowiſh one, four ounces and three drams of a thicker yellow Oil, and two ounces one dram of a dark browniſh-red empyreumatic Oil of the conſiſtence of Balſam, and commonly diſtinguiſhed by that name.

The eſſential Oil, called Spirit of Turpentine, is remarkably difficult of ſolution in Spirit of Wine, though Turpentine itſelf diſſolves eaſily. One part of the Oil may indeed be diſſolved in ſeven parts of rectified ſpirit, and the ſolution is in appearance perfect; but on ſtanding for a little while, the limpid liquor becomes milky, and by degrees greateſt part of the Oil ſeparates and falls to the bottom, a much larger proportion of the ſpirit being requiſite to keep it diſſolved.

Uſes of TURPENTINE. Turpentine, and the Reſin left upon diſtilling it, are employed in various cements, lacquers, varniſhes, in fire-works, *&c.* As a medicine, it is a hot, ſtimulating, detergent, diuretic, poſſeſſing at the ſame time in a notable degree, the healing and corroborating virtues of the other Balſams. The Oil is far more ſtimulating than the Turpentine itſelf; and hence, in many caſes where ſuch a quality would be very injurious, the Reſin or Turpentine freed from the hot Oil is given with ſafety. Both Turpentine itſelf and its preparations are of frequent uſe alſo externally, in plaſters, digeſtive ointments, and vulnerary Balſams. The Oil is ſaid to be particularly ſerviceable in wounds of the nervous and tendinous parts; and a ſolution of it in Spirit of Wine, applied warm, to be one of the moſt effectual ſtyptics in profuſe hæmorrhages.

Tar. IF the wood of the Turpentine-trees be expoſed to the fire, in a veſſel everywhere cloſed except an aperture at the bottom, as for example in a retort with the neck placed lowermoſt, the reſinous juice melts out by the heat and at the ſame time contracts an empyreumatic ſmell and taſte: In this ſtate it is Tar. Tar is prepared in different parts of Germany, Norway, Sweden, *&c.* from the Pine and the Fir-trees, and in ſome places from the Larch and the Terebinth. The wood is incloſed in a large oven, to the quantity of ten or more loads at a time: This ſtands within another oven called the mantle, the ſpace betwixt them receiving the fire: From the bottom of the inner oven runs a gutter, by which the Tar is conveyed off in proportion as it melts out from the wood.

Pitch. Tar boiled down to dryneſs, is the common black Pitch: This part of the proceſs is commonly performed in a ſtill, in order to ſave an eſſential Oil which ariſes in the boiling, and which is called from the name of the tree which Tar is principally prepared from, *Oleum pini*, and *Oleum tædæ*. This Oil is greatly valued by painters, varniſhers, *&c.* on account of its drying quality: It ſoon thickens of itſelf, almoſt to the conſiſtence of a Balſam. Along with the Oil there comes over a watery liquor, which the workmen injudiciouſly throw away: It is a good acid ſpirit, capable of being applied to ſundry uſeful purpoſes: I know a perſon in France who has ſaved by it ſeveral thouſand dollars.

Oleum pini.

Acid ſpirit.

Experiments on Pitch. Pitch is not, as ſome have ſuppoſed, a pure and perfect Reſin: It has not only ſuffered a notable change from the heat employed in its preparation, but likewiſe participates of the other principles of the wood, of gummy and ſaline matter, and of a burnt earth. Hence its diſpoſition to ſeparate and precipitate when melted with Oils, Fats and Reſins, into plaſters and ointments: And

hence it is gradually corroded by air and moiſture when employed as a cement or defence for wood or other ſubſtances, in ſhips, land-carriages, ciſterns, caſks, ſhingle coverings for houſes, &c. Ship-builders endeavour to improve their Tar and Pitch, ſo as to render them more durable by various additions (*d*). TURPENTINE.

Two ounces of dry Pitch, treated with rectified Spirit of Wine, gave but one ounce and half a ſcruple of reſinous extract: Half an ounce of an empyreumatic Oil ſeparated during the digeſtion, and there remained undiſſolved half an ounce of earthy matter, from which water would extract nothing. The ſame quantity of the ſame Pitch boiled at firſt in water, yielded two drams and half a ſcruple of gummy extract: From the remainder, nevertheleſs, were obtained ten drams of ſpirituous extract, that is, near two drams more than when ſpirit was applied at firſt, the indiſſoluble part amounting as before to half an ounce. The diſtilled water ſmelt and taſted almoſt like red herrings: The ſpirit had no remarkable impregnation. Eight ounces of Pitch diſtilled in an open fire, yielded two ounces one dram and a half of an acid ſpirit, and two ounces five drams of a fetid Oil, three ounces of a ſhining black coal remaining in the retort.

The uſe of Pitch as a medicine, unleſs for external purpoſes, is not to be recommended. The Pitch ſcraped off from beer caſks was the Arcanum of a certain midwife againſt uterine hæmorrhages, and indeed ſeldom failed to reſtrain the flux, but commonly in a few days brought on unfavourable conſequences.

The ſoot which ariſes in the burning of Pitch, is the ſubſtance commonly ſold under the name of Lamp-black: In France, the Pitch is burnt for this purpoſe in a kind of furnace made of tiles, ſo diſpoſed as to prevent the eſcape of the ſmoke (*e*). Lamp-black.

THE

(*d*) *Additions for rendering Tar more durable.*] An anonymous correſpondent of the Swediſh academy obſerves, that the tarred or pitched boards and ſhingles, with which houſes in many places are covered, are ſoon damaged by heat and moiſture, the ſun's heat melting off the Tar, ſo that the wood remains bare. Some have endeavoured to prevent this, by laying on the Tar late in the year, that the winter's cold might fix it; an expedient of ſome uſe, but very far from being effectual; for however the Tar may be hardened by the winter, the return of ſummer ſoon makes it ſoft again. Others have mixed ſmith's cinders with the Tar, which inſtead of mending the matter makes it worſe, and all ponderous ſubſtances do the ſame. He ſays he has never found any addition comparable to Coal-duſt [that of Charcoal he ſeems to mean,] which is to be ſtirred into Tar made hot, in ſuch quantity as to render it thick: The mixture is to be laid on with wooden trowels, in a hot day. Tar thus prepared, he ſays, is fixed, never runs, binds and hardens ſurprizingly from heat and moiſture, and ſhines better than Oil varniſh.

(*e*) *Lamp-black.*] What is called Lamp-black (originally perhaps the ſoot collected from lamps) is obtained, in different parts of Germany, Sweden, &c. not from pure Reſin or Pitch, but from the dregs and pieces of bark of the tree ſeparated in their preparation. For making common Reſin, the impure juice collected from inciſions in Pines and Fir-trees, is boiled down with a little water, and ſtrained whilſt hot through a ſack: On cooling, the Reſin congeals upon the ſurface of the water, and is then packed up in barrels; it is diſtinguiſhed according to its colour, into white, yellow and brown. The droſs left on ſtraining, is burnt for Lamp-black, in a low oven, from which the ſmoke is conveyed by a long paſſage into a ſquare chamber, having an aperture in the top, upon which a large ſack is faſtened: The ſoot concretes partly in the ſack,

VI. SOLID STORAX.

THE moſt fragrant of the ſolid Reſins, and indeed of all the known vegetable ſubſtances, is STORAX or Styrax, obtained from a tree of the ſame name ſaid to grow moſt plentifully in Syria, Cilicia and Pamphylia. America likewiſe produces Storax-trees, but not that particular ſpecies which affords the officinal Reſin. The true Storax-tree has leaves like thoſe of the Quince, and hence is named by Caſpar Bauhine and Tournefort *Styrax folio mali cotonei:* Its flowers are white, in ſhape ſomewhat like a funnel, divided into ſeveral ſegments about the edges: The fruit is about the ſize of a Hazel-nut.

The fine Storax, called red Storax or Storax in the tear, is the pure native juice, flowing from inciſions made in the trunk of the tree. This is very rarely to be met with among us——The common Storax is ſuppoſed to be in part an artificial compoſition, mixed with a conſiderable portion of the genuine Reſin (*f*); Pomet goes ſo far as to ſay, that he knew the way of making it. This ſort was formerly brought to us incloſed in reeds or canes, whence its name *Styrax calamita:* At preſent we meet with it in large cakes or loaves, of a reddiſh brown colour, ſoftiſh and as it were unctuous to the touch, yet brittle and friable, intermixed with a notable quantity of ſaw-duſt, of an extremely pleaſant ſweet ſmell.

Out of an ounce of common Storax, rectified Spirit of Wine diſſolved ſix drams: From the reſiduum, water extracted half a dram of gummy matter: The reſt was almoſt mere ſaw-duſt. Another ounce of the ſame Storax treated with water at firſt, gave two drams of extract; after which, it yielded with ſpirit four drams of Reſin, the ſaw-duſt remaining as before.

Pure ſpirit elevates in diſtillation very little of the ſmell of the Storax: The diſtilled water is notably impregnated with its fine flavour, but no ſeparable Oil.

ſack, which is occaſionally removed, and partly in the chamber and canal, from which it is ſwept out.

Lamp-black is more oily or reſinous than the common wood ſoot: It gives out more to ſpirit and leſs to water by infuſion, and yields a larger quantity of Oil on diſtillation. Mixed with boiled Oil, and a little boiled Turpentine, it forms the black compoſition uſed as ink in printing.

(*f*) *Common Storax.*] Of the production of this concrete, we have no ſatisfactory account . . . That it is not an artificial compoſition, may be judged from hence; that notwithſtanding its large admixture of ſaw-duſt, it is more fragrant than the pure Storax in the tear, and its fragrance is exactly of the ſame kind. Some reſinous bodies indeed diſcover a greater degree both of ſmell and taſte, when diluted with other ſubſtances of themſelves inodorous and inſipid, than in their pure ſtate: But the pure Reſin extracted from common Storax by Spirit of Wine, is ſtill more fragrant than the Storax itſelf, and than the Reſin prepared by the ſame means from Storax in the tear.

It ſeems probable, that the pure Storax is the juice which concretes upon the tree, and which has loſt in the drying, its more ſubtile odoriferous parts; and that the common Storax is the juice received immediately in veſſels, and mixed with ſaw-duſt enough to thicken it; the ſhops requiring under the name of Storax a ſolid or conſiſtent maſs, and evaporation being found to diſſipate its fragrance. At leaſt I cannot conceive for what other purpoſe the woody matter could be added; for it is too eaſily diſtinguiſhable to have been intended as an impoſition.

The Storax-tree is ſaid to grow ſpontaneouſly, not only in the eaſtern countries, but in Italy; whether it yields any Reſin there we have no account. It ſcarcely bears the winters of our climate without ſhelter.

Oil is obtained. To determine this laſt point more fully, I diſtilled eight ounces of Storax with ſixteen ounces of water in a glaſs retort: No appearance of Oil could be perceived till the water was almoſt all drawn off, and the remaining Storax begun to grow dry and ſcorched: Then aroſe a fine ſubtile Oil, weighing two ſcruples, together with nine drams of an empyreumatic liquor: Preſently ſucceeded two drams and a ſcruple of thick butyraceous Oil, and afterwards two ounces one dram of an empyreumatic Oil, which had nothing of the ſmell of the Storax, along with five drams of an acid ſpirit: The reſiduum weighed two ounces and ſeven drams. The butyraceous Oil being waſhed with warm water, and the water ſet by in a cold place, a ſmall portion of ſaline matter ſeparated, ſimilar in appearance to the flowers of Benzoine. SOLID STORAX.

Though rectified ſpirit diſtilled from Storax, brings over little or nothing of its ſmell; we may nevertheleſs obtain a ſpirit pretty ſtrongly impregnated both with the ſmell and taſte of the Storax, by previouſly mixing the Reſin with twice its weight of Salt of Tartar, and drawing over a rectified Spirit of Wine from this mixture. The ſtrongeſt and moſt fragrant principle, ſeparable from Storax, is the ſubtile, ſlightly empyreumatic Oil, which ariſes firſt in the diſtillation of it.

Storax is employed in medicine as a corroborant and reſolvent, both internally, and in plaſters and ointments: But its principal uſe is in perfumes of various kinds. For the nicer purpoſes, it ſhould be purified by diſſolving it in Spirit of Wine, and gently drawing off the ſpirit. Some boil the Storax in Wine, till it becomes ſoft enough to be preſſed from its impurities through a ſtrainer: This method is leſs eligible than the other, as a part of the Storax is retained among the ſaw-duſt. Mr. Charas obtained by expreſſion, only three ounces of purified Reſin from eight ounces of Storax, whereas by Spirit of Wine, the yield is juſt double.

VII. LIQUID STORAX.

IN the ſhops we meet with a fluid reſinous ſubſtance, called STYRAX LIQUIDA. This is ſaid by ſome to be extracted by expreſſion from the bark of the Storax-tree; by ſome from the leaves, or the leaves and bark together (*g*), and by others, to be a compoſition of Turpentine, Oil, Wine, and a little

(*g*) *Liquid Storax.*] The genuine liquid Storax is obtained not from the tree which yields the ſolid Storax, but from one of a different genus, though uſually called by the ſame name. That which yields the ſolid is diſtinguiſhed by the epithet *Quince-leaved*, and that which yields the liquid by that of *Maple-leaved* Storax.

The Maple-leaved Storax-tree is a native of Virginia, Mexico, and ſome other parts of America, and is eaſily naturalized to our own climate. A reſinous juice, approaching in fragrance to Storax, exudes upon the ſurface of the leaves, and may be extracted more perfectly by Spirit of Wine: The proceſs by which the juice is procured abroad has not been tried with the trees raiſed here.

Liquid Storax and liquid Amber are ſaid to be both obtained from this one tree, the firſt by boiling the bark or branches in water, the latter by making inciſions in the trunk——Mr. Petiver gives an account in the Philoſophical Tranſactions, of the preparation of liquid Storax, as practiſed in the iſland Cobros in the Red-ſea, from a tree (which probably is no other than this) called by the Turks and Perſians Roſa-Mallos. The bark is annually cleared off, and boiled in ſea-water to the conſiſtence of Bird-lime: The reſinous matter, which floats

LIQUID STORAX. a little ſolid Storax. This laſt account is the moſt probable. There is a perſon in our neighbourhood [Berlin] who prepares ſome hundred weights every year, and is ſaid to employ chiefly common Reſin.

Four drams of liquid Storax yielded, with rectified Spirit of Wine, three drams and one ſcruple of reſinous extract: From the remaining two ſcruples, Water took up only a few grains: The diſtilled ſpirit ſmelt a little of the Reſin. In diſtillation with Water, an eſſential Oil aroſe, ſimilar in flavour to Oil of Turpentine or the *Oleum pini*. By diſtillation in a ſtronger fire, inſtead of a clear empyreumatic Oil, what came over was almoſt mere pitch. Theſe experiments are a ſufficient proof that the common liquid Storax is an artificial compound.

THYMIAMA. THE CORTEX THYMIAMATIS, called by the ancients *Thus judæorum* from its uſe among the Jews in fumigations, is ſuppoſed to be the bark of the Storax-tree, remaining after the genuine Liquid-ſtorax has been extracted by expreſſion or boiling. Greateſt part, however, of what we now and then meet with under this name in the ſhops, is no other than the bark of European trees, artificially impregnated with reſinous matter. We may be aſſured that this is the caſe, where the Thymiama, like that examined by Hoffmann, abounds with Reſin (*b*).

VIII. BENZOINE. BENZOINE, *Benzoinum*, *Benzoe*, *Belzoe*, *Aſa dulcis*, comes the neareſt in fragrancy to Storax. The tree which produces Benzoine is a native of the Eaſt Indies, particularly of the iſlands Siam and Sumatra. It has ſoft thin leaves, nearly like thoſe of the Citron-tree, and bears a round fruit about the ſize of a hazel-nut: It is never permitted to exceed the ſixth year, as being after

floats upon the ſurface, and contains a conſiderable portion of the ſubſtance of the bark, is taken off, liquefied again in boiling Water, and paſſed through a ſtrainer. The purer part which paſſes through, and the more impure which remains on the ſtrainer, are both ſent to Mocca, from whence they are ſometimes, but very rarely brought to us. The firſt is of the conſiſtence of Honey, tenacious like Turpentine, of a browniſh colour, an acrid aromatic unctuous taſte, and a ſmell approaching to that of ſolid Storax, but ſo ſtrong as to be diſagreeable. The impure ſort is full of woody matter, and much weaker in ſmell.

The liquid Amber, or juice which iſſues from inciſions in the trunk, is at firſt of the conſiſtence of thin Turpentine, but by long keeping grows hard and brittle. It is of a yellow colour inclining to red, of a hot aromatic taſte, and a fragrant ſmell, not unlike that of Storax heightened with a little Ambergris. It was formerly much uſed as a perfume, but is at preſent ſcarcely known in the ſhops.

(*b*) *Hoffmann's experiments on the Cortex thymiamatis.*] This ſubſtance, common he ſays in the German ſhops (but ſcarcely ever to be ſeen in ours) has the appearance of a mixture of bark and leaves bruiſed and preſſed; and approaches in ſmell to liquid Storax. Rectified Spirit of Wine extracted from it a black tincture, ſimilar to a ſpirituous ſolution of Balſam of Peru. The liquor poured into Water became immediately milky: The ſpirit, drawn off by diſtillation, was of a very fragrant ſmell, ſo diffuſive that a ſingle dram impregnated with its fragrance ſome quarts of Water: The Reſin, which remained, had alſo a very pleaſant fragrance, and amounted to at leaſt two ounces from a pound of the bark.

after this period unfit for yielding Reſin; the inhabitants then cut it down, and ſupply it by a young one raiſed commonly from the fruit. One tree does not yield above three pounds of Benzoine (*i*). BENZOINE.

The juice exudes, from inciſions, in form of a thick white balſam: If collected as ſoon as it has grown ſomewhat ſolid, it proves internally white like almonds, and hence is called *Benzoe amygdaloides:* If ſuffered to lye long expoſed to the ſun and air, it changes more and more to a browniſh, and at laſt to a quite reddiſh brown colour. The dealers in this commodity never ſell us the fine white Benzoine by itſelf; but mix it with the inferior and fouler kinds, that one may carry off the other: Hence, in the very beſt Benzoine of the ſhops, we meet with pieces of various colours, white, yellowiſh white, yellow, browniſh yellow, brown, reddiſh brown, and grey, all united into one lump. The dark coloured Benzoine however, if it is free from earthy and woody impurities, and from admixtures of any other Reſin, does not appear to be inferior in goodneſs to the white.

This Reſin is moderately hard and brittle; and yields, on being rubbed or warmed, an extremely agreeable ſweet ſmell. It totally diſſolves in Spirit of Wine into a blood red liquor, leaving only the impurities, which amount commonly to no more than about a ſcruple, upon an ounce. To Water, it gives out a portion, not of gummy or mucilaginous, but of ſaline matter, of a peculiar kind, volatile and ſublimable in the fire, and which indeed is moſt effectually ſeparated by dry ſublimation, and hence called *flowers* of Benzoine. Such a ſubſtance is ſuppoſed to be obtainable from Benzoine alone: I have diſcovered however, a like ingredient in ſolid Storax and in Balſam of Peru; and from the mineral kingdom alſo we may bring Amber in compariſon with it. Flowers of Benzoine.

Some prepare the flowers from Benzoine by itſelf, reduced into groſs powder; others mix it, in fine powder, with an equal quantity of waſhed ſand. An earthen pot or jar is filled with the matter to one half or one fourth its height, then covered with a conical paper cap, and placed in ſand: By a gentle heat, the flowers ariſe into the cap, which, as ſoon as any conſiderable quantity is judged to be collected, is removed, and ſupplied by another, and the proceſs continued till nothing more will ſublime: The remaining Benzoine, which appears of a blackiſh brown colour, may ſtill be uſed, if no ſand has been mixed, in compoſitions for yielding an odoriferous ſmoke, and for other like purpoſes. This method is not a little troubleſome, the quantity of flowers obtained by it ſmall, and the flowers themſelves commonly

(*i*) *Benzoine.*] The Benzoine-tree (or at leaſt one which is ſuppoſed to be the ſame with that which affords Benzoine in the Eaſt Indies) is plentiful alſo in Virginia and Carolina, and has been thence brought into England, where it grows with vigour in the open ground. The bark and the leaves ſmell like Benzoine, and yield with rectified Spirit a Reſin of the ſame ſmell; but no Reſin has been obſerved to iſſue from it naturally in this climate; nor, ſo far as we can learn, has any Benzoine been collected from it in America; though Commeline calls it *Arbor Virginiana, citreæ vel limonii folio, Benzoinum fundens*, the Virginian-tree, with leaves like thoſe of the Citron or Lemon-tree, *yielding* Benzoine. In its flowers and fructification it agrees with the bay, and hence is ranked by Linnæus as a tree of that genus, under the name of *Laurus foliis enerviis ovatis utrinque acutis integris annuis*, the bay with oval undivided leaves, pointed at both ends, not ribbed, falling off in the winter.

BENZOINE. monly tinged of a yellowiſh or even a brown colour from ſome of the Oil of the Benzoine ariſing with them; for as the ſand grows continually hotter and hotter, it is ſcarce poſſible to prevent the heat increaſing ſo far as to elevate a portion of the Oil.

The beſt way is, to moiſten the Benzoine, groſsly powdered, with Spirit of Wine; and then proceed to diſtillation, with a very gradual ſand heat, in a wide necked glaſs retort. The flowers ariſe immediately after the ſpirit, partly in a concrete ſaline form, and partly in that of a white butter: The receiver being now changed, and the fire ſlowly increaſed, a ſmall portion of brown coloured flowers ſublimes, followed firſt by a ſubtile Oil, afterwards by a browniſh Oil, and at laſt by a black, thick, empyreumatic one, together with an acid ſpirit. If the flowers and butter be diſſolved in diſtilled Water over a gentle fire, the ſolution paſſed through a filter and ſet in the cold; the ſaline matter ſhoots into cryſtalline concretions, of a fine ſilver whiteneſs; this Salt, like Tartar, being difficult of ſolution, and when diſſolved in hot Water, ſeparating again as the liquor cools: The diſſolution and filtration ſhould be performed as expeditiouſly, and the veſſel kept as much covered, as poſſible, to prevent any conſiderable diſſipation of the volatile matter. The Salt ſtill retains, even after this purification, a portion of Oil; as appears from its penetrating ſmell, and from its burning in the fire. The Spirit of Wine, which ariſes at firſt in the diſtillation, is impregnated with a little of the Salt. The Oil which follows the flowers, rediſtilled from earthy powders, or with Water, may be uſed as an eſſential Oil of Benzoine, for it has little or nothing of an empyreumatic taint. From ſixteen ounces of Benzoine are obtained two ounces of rough flowers, nine ounces of Oil, and ſeven ſcruples of an acid ſpirit: The reſiduum weighs two ounces and a half.

Benzoine and its flowers are employed medicinally for reſolving and attenuating viſcid juices, particularly in diſorders of the breaſt: But the principal uſe of this fragrant Reſin is in perfumes, and as a coſmetic, for ſoftening and ſmoothing the ſkin. For this laſt purpoſe, the Benzoine is diſſolved in Spirit of Wine, with the addition ſometimes of Storax: The ſolution, mixed with Virgins milk. Water, forms a white liquor called *Virgins milk*; which on ſtanding, ſlowly depoſites a fine white magiſtery. Some add, to the tincture of Benzoine, a tincture or ſolution of litharge in Vinegar, and thus obtain a *Compound* virgins-milk and magiſtery, leſs innocent than thoſe from Benzoine alone——A ſmall quantity of the Oil of Benzoine heightens the ſmell of perfumes, and corrects rancid unguents and balſams.

IX. TACAMAHACA is a fragrant Reſin collected in America. The tree TACAMAHACA which produces it is called by John Bauhine *Tacamahaca populo ſimilis, fructu colore pæoniæ*, Tacamahaca-tree reſembling the poplar, bearing a fruit whoſe colour is like that of Peony: The wood is named by the Engliſh, from the uſe to which it is principally applied, Saddle-wood (*k*).

The

(*k*) *Tacamahaca-tree.*] This tree is a native of the more temperate parts of America, but bears the winters of our own climate, and yields, in the young buds or rudiments of the leaves which come forth early in the ſpring, a very fragrant balſam or Reſin, ſimilar in ſmell to the Tacamahaca brought from abroad. In its balſamic buds, as in its general appearance, it has a great reſemblance to the poplar.

The Reſin which exudes ſpontaneouſly from the tree, is greatly ſuperior to that which iſſues from wounds. The firſt is collected in gourd-ſhells, and proves of a clear ſemitranſparent yellow colour: This is rarely to be met with. The ordinary Tacamahaca conſiſts of tears of various colours, reddiſh, yellowiſh, grey, brown, blackiſh, clear and opake, pure and impure, joined together into one maſs, of a ſolid conſiſtence, partly reſembling Benzoine, intermixed with leaves and other vegetable matters. TACAMAHACA.

This Reſin, when in perfection, has an aromatic taſte, and a very pleaſant ſmell, approaching to that of Lavender or Muſk. It diſſolves totally, if pure, in rectified Spirit of Wine: Out of an ounce, there remained only about eighteen grains undiſſolved; and theſe were wholly an heterogeneous matter, on which Water had no action. Water, applied at firſt, extracted only about ſeventeen grains from an ounce. In diſtillation, neither Water nor ſpirit bring over any thing conſiderable: this Reſin being very tenacious of its flavour. It is uſed chiefly in plaſters and fumigations.

LADANUM or Labdanum is the produce of a ſmall ſhrub; which is a ſpecies of *Ciſtus* or Rock-roſe, growing plentifully in the warmer climates, particularly in Greece, in the iſland Candy, as alſo in Portugal and Spain, called by Tournefort *Ciſtus ladanifera cretica flore purpureo*. The ſhrub is only two or three feet in height: Its leaves are ſomewhat like thoſe of Sage; the flowers pentapetalous, of a purple colour variegated with a roſe red. LADANUM.

The Reſin exudes, not from the ſtem, but upon the ſurface of the leaves. It was formerly collected only from the beards of goats who browſed upon the plant, and in this manner a little is ſtill procured: Hence the hairs intermixed in ſome of the maſſes of Ladanum, called *Ladanum à barbis*. The greateſt quantities are now collected in Candy, by drawing over the plant, backwards and forwards, in the calmeſt and hotteſt weather, a kind of rake with leathern thongs inſtead of teeth: The tenacious juice adheres to the thongs, and is afterwards ſcraped off with knives. It is ſaid that one perſon can thus collect three pounds and two ounces in a day. As the plant grows chiefly upon dry ſandy hills near the ſea-ſhores, where there is conſtantly a little wind, the Reſin can never be procured free from an admixture of duſt: The collectors alſo purpoſely mix with it a certain fine black ſand, found in the neighbourhood, not diſtinguiſhable by the eye from the Ladanum itſelf. In Spain, a more expeditious method is purſued: The leaves of the ſhrub are boiled in Water, and the Reſin, which ariſes to the ſurface, ſcummed off. The Ladanum thus obtained is one of the worſt kinds; the more ſubtile and volatile parts of the juice being diſſipated in the boiling.

Good Ladanum looks like a maſs for making pills, of a blackiſh grey or an unſightly black colour: It is untranſparent, eaſy to break, free from any viſible impurities, of a bitteriſh and aſtringent taſte: It readily ſoftens over the fire, and when laid on burning coals, yields an agreeable ſmell. The admixture of ſand may be diſcovered by its grittineſs betwixt the teeth when long chewed, but more perfectly by ſolution.

From ſixteen ounces of Ladanum I obtained, by rectified Spirit of Wine, eleven ounces two drams and two ſcruples of Reſin: The remainder yielded with

LADANUM. with Water, an ounce of gummy extract; three ounces five drams and one ſcruple of indiſſoluble matter being left. On treating the ſame quantity of Ladanum firſt with Water, I had two ounces four ſcruples of a gummy or rather gummy-reſinous extract: The reſiduum, treated with ſpirit, gave ten ounces two drams two ſcruples of pure Reſin; three ounces and a half of indiſſoluble impurities remaining. In diſtillation with Water, a very ſmall portion of an eſſential Oil ariſes: Spirit of Wine likewiſe brings over ſo much oily matter, as to ſmell and taſte ſtrongly of the Ladanum, and grow milky upon the admixture of Water.

This Reſin is employed in plaſters and ointments, as a coroborant and diſcutient, but principally as an ingredient in odoriferous compoſitions, and fumigations. It ſeems to be one of thoſe drugs which, in all the intentions it has been uſed for, may be ſpared without much inconvenience.

XI. ELEMI. ELEMI is a Reſin of Aſiatic origin: The plant, which produces it, is not as yet known with certainty. There is alſo an inferior kind, brought from America which is the only one now to be met with in the ſhops: The parent of this ſort is called by Ray *Arbor Brazilienſis gummi elemi ſimile fundens, &c.* a Brazilian-tree, yielding a gum like Elemi, with winged leaves, verticillate flowers, and a fruit about the ſize and ſhape of an olive.

The true Elemi comes over in large oblong maſſes or round loaves, generally wrapt up in leaves of the Indian reed. It is of a yellowiſh or rather greeniſh white colour; ſemitranſparent; of a ſoft conſiſtence, betwixt that of Wax and Turpentine, or dry on the outſide and ſoftiſh within: By age, it grows hard and brittle throughout. It has a moderately ſtrong, not unpleaſant ſmell; reſembling that of a mixture of Fennel, Daucus, and Smallage-ſeeds. It is commonly full of impurities, which are obvious enough to the eye.

Out of ſixteen ounces of the purer maſſes, rectified Spirit of Wine diſſolves fifteen: Of the remaining ounce, Water takes up only one ſcruple. Water applied at firſt diſſolves, out of the ſame quantity two drams and two ſcruples: From the remainder, ſpirit extracts fourteen ounces of Reſin. Both Water and ſpirit become ſtrongly impregnated with its flavour by diſtillation: Along with the Water ariſes a very elegant and grateful eſſential Oil, amounting to an ounce from ſixteen ounces of the Elemi.

Neither the Oil, the Spirit, or the Water, have as yet been received in medicine; though I am convinced they are applicable to valuable purpoſes; provided we are on our guard, in the choice of the Elemi, againſt the too common ſophiſtications or counterfeits made with boiled Turpentine and other matters. This Reſin has hitherto been employed only in external applications; in nervine, vulnerary, and digeſtive plaſters and balſams. In making theſe kinds of compoſitions, we muſt be careful to avoid too great a degree of heat in mixing the ingredients; leſt the eſſential Oil, the moſt uſeful part of the Elemi, be loſt.

XII. ANIME. ANIME, *Amine*, or *Cancamum*, is obtained from an American-tree, of which we have no very certain account, ſaid to grow chiefly in New Spain and Brazil.

Brazil. The Reſin is brought over in yelloviſh white, tranſparent, ſomewhat unctuous tears, and partly in larger maſſes, brittle, of a light pleaſant taſte, eaſily melting in the fire, and burning with an agreeable ſmell. ANIME.

It diſſolves totally in rectified Spirit of Wine, the impurities only being left, which commonly amount to no more than about five grains on an ounce. Water extracts about half a dram from an ounce: The decoction inſpiſſated leaves an unctuous maſs, which makes the fingers manifeſtly oily. The ſpirit drawn off by diſtillation, ſmells and taſtes conſiderably of the Anime: The diſtilled water diſcovers on its ſurface ſome ſmall portion of an eſſential Oil.

This Reſin is uſed chiefly in nervine, cephalic and reſolvent plaſters. It can ſcarcely operate any otherwiſe than as a mere reſinous ſubſtance, and may not improperly be ſupplied by cheaper Reſins. Greateſt part of what we meet with under this name in the ſhops, is indeed no other than common Reſin, flavoured with a little of the eſſential Oil of a certain umbelliferous plant.

XIII. MASTICH.

MASTICH is the produce of a ſmall tree, called Lentiſk or *Lentiſcus*. The bark of the tree is unequal, rugged, and of a grey colour, the branches tough and flexible, the leaves winged and ſet in pairs, and the flowers, which come forth in cluſters, apetalous or imperfect. The fruit, at firſt like a red berry, is when ripe a ſhining black nut.

The wood of this tree was formerly of conſiderable eſteem in medicine, and has of late years alſo been celebrated for a variety of virtues, particularly that of ſtrengthening the nerves, by Joh. Bapt. de Wengh and John de Muralto, in the *Ephemerides naturæ curioſorum*. It ſeems however to be better fitted for the uſe to which the Turks and others apply it, the making of lances and tooth-picks. Such at leaſt as we meet with in the ſhops is entirely inert. Good Maſtich-wood is ſaid to be hard and ponderous, externally grey, internally white, and of an aſtringent taſte: The officinal ſort is whitiſh on the outſide, reddiſh within, and oftentimes worm eaten. Pomet relates, that the Miſletoe of the Hazel-tree is frequently ſold in France for Maſtich-wood: This report is the more extraordinary, as the Miſletoe is vaſtly ſlenderer than Maſtich, and as a ſpecies of the Maſtich-tree itſelf grows naturally in that kingdom.

The common Maſtich-tree, *Lentiſcus vulgaris*, is found in France, Italy, Portugal and Spain; but this ſpecies yields little or no Reſin. That which affords Maſtich is the produce of the iſland Chio, and diſtinguiſhed in the catalogue of the Amſterdam garden by the title of *Lentiſcus vera ex inſula Chio cortice & foliis fuſcis*. About the beginning of Auguſt, the inhabitants make inciſions with large knives in the bark of the trunk, and in a few days after the juice begins to exude. About the end of September, they make freſh inciſions in the parts before untouched, and thus collect a little more. When the tears have grown dry and hard, they are cleanſed from ſand, &c. by ſifting, an operation very troubleſome to the workmen, as the fine duſt of the Maſtich ſticks about the eyes, ſo as ſcarcely to be got off with Oil.

Two ſorts of Maſtich are diſtinguiſhed in trade, choice Maſtich, or Maſtich in grains, and a more impure dark-coloured kind, called Maſtich in ſorts, or ſimply Maſtich. For plaſters and other like purpoſes, the purer pieces of this

MASTICH. laſt kind are commonly made uſe of; but ſome care is requiſite in the choice, common Reſin or Frankincenſe being often mixed with it. Good Maſtich is of a pale yellowiſh colour, in roundiſh or ſomewhat oblong tears, clear and tranſparent, dry without any unctuoſity. It has a pleaſant light ſmell, and in burning yields a ſmoke not diſagreeable. In chewing, it impreſſes a ſlight not ungrateful taſte, and becomes ſoft and tough like Wax: By this mark, ſophiſtications of it with Sandarach are readily diſtinguiſhed, that Reſin proving friable betwixt the teeth.

Maſtich diſſolves almoſt totally in rectified Spirit of Wine: It is pretty ſingular, that during the digeſtion a portion ſeparates, indiſſoluble in the ſpirit, though in appearance reſinous, amounting to about two ſcruples upon an ounce of the pure grains. Water far from diſſolving Maſtich, as ſome pretend it does, has no action either on Maſtich itſelf or on this reſiduum. In diſtillation, nothing ariſes with ſpirit, and nothing conſiderable with water. Hoffman, however, has diſcovered a method of impregnating rectified ſpirit by diſtillation, both with the ſmell and taſte of the Maſtich: He mixes the Reſin with an equal quantity of Salt of Tartar, then adds the ſpirit, and proceeds to diſtillation in a glaſs body with a very gentle fire.

Maſtich is made an ingredient in various kinds of varniſhes, and employed medicinally as a corroborant and reſtringent. It is chewed for ſweetening the breath, preſerving the teeth, and ſtrengthening the gums; and from this uſe as a maſticatory is ſuppoſed to have received its name. Large quantities are ſent annually from Chio, by way of tribute, to the Grand Signior; greateſt part of which is conſumed for thoſe purpoſes at court. This tribute of Maſtich is ſaid to amount to the value of four or five thouſand ducats: According to Tournefort's account, it muſt conſiderably exceed that ſum.

XIV. GUAIACUM. GUM GUAIACUM, ſo called, is a Reſin exuding from the Guaiacum-tree, of which hereafter. It is of a brown colour, partly reddiſh, and often greeniſh, brittle, of a gloſſy ſurface when broke, of a pungent taſte, and when rubbed or heated, of a not diſagreeable ſmell: Its ſmoke in burning, has ſomewhat the ſmell of that of wood. Such ſhould be choſen as has pieces of the bark adhering, and eaſily parts from them by a few quick blows. The maſſes which have no bark, eſpecially the large ones, are often ſophiſticated: I received for Gum guaiacum, a whole box of an artificial compoſition of Colophony and Balſam of Sulphur: This abuſe was readily diſtinguiſhable by the ſmell of the compound when laid upon burning coals, and even by its appearance upon breaking.

Out of an ounce of Gum guaiacum, rectified Spirit of Wine diſſolves ſix drams and two ſcruples: Of the remainder, water takes up only ten grains, all the reſt being an indiſſoluble earth. Water applied at firſt, extracts four ſcruples out of an ounce: Of the reſiduum, ſpirit diſſolves four drams and two ſcruples. In diſtillation, it gives over a little both to water and to ſpirit, ſo little as to be altogether inconſiderable.

Its virtues are the ſame with thoſe of the wood. It is uſed pretty frequently in England, very rarely in Germany, the pure Reſin artificially extracted from

the wood by means of Spirit of Wine, advantageouſly and elegantly ſupplying its place (*l*). GUAIACUM.

CLASS

(*l*) *Additional articles.*] COPAL. This Reſin is brought in irregular lumps from New Spain, where it is ſaid to be obtained from different ſorts of large trees, of which eight are deſcribed by Hernandez. Some pieces are whitiſh, ſemitranſparent, friable, not unlike the finer kinds of common Reſin groſsly powdered and forced together into a maſs. Others are more tranſparent and leſs friable, and of a yellowiſh or brown colour. It has a more agreeable ſmell than Frankincenſe, to which ſome have reſembled it, and does not melt ſo thin or burn away ſo faſt upon a red-hot iron. It does not ſoften in the mouth, on being chewed, like Anime with which it has been confounded by others. From theſe and other reſinous bodies it differs more remarkably, in its being exceeding difficultly diſſoluble in rectified Spirit of Wine.

Solutions of Copal have been greatly eſteemed as varniſhes, and the method of making the ſolution kept a ſecret in particular hands: Juncker informs us, that it readily ſucceeds, if Spirit of Sal ammoniac, mixed with a due proportion of Oil of Spike or Oil of Turpentine, is uſed for the menſtruum.

DRAGONS BLOOD.

DRagons Blood, *Sanguis draconis*, is a Reſin of a red colour, brought from the Eaſt-Indies. There are two ſorts of it; one in ſmall oval drops or tears, of a fine deep red, which is heightened into a crimſon on grinding them into powder; the other is in larger maſſes, apparently compoſed of tears: Of theſe, ſome are of a pale dull red, others of a deep one not at all inferior to the drop ſort.

The drops and the lumps are ſuppoſed to be the produce of two different trees. The lump ſort is ſaid to exude from the trunks of certain palms growing in the Madera and Canary iſlands; the drop to be artificially extracted from the fruit of a tree. According to Kæmpfer, the fruit is laid upon a kind of hurdle, over a large veſſel half full of water: The whole being lightly covered, the water is made to boil, when the fruit being ſoftened by the ſteam, a red juice, which was not diſcoverable in it before, appears upon the ſurface: This is ſcraped off upon flag leaves, and expoſed to the air to dry. The ſame author informs us that ſome of the preparers of this commodity boil the fruit in water, till all the colouring particles are extracted or melted out; after which, the aqueous fluid is evaporated till the remainder begins to thicken, when it is further exſiccated upon flag leaves as before.

This drug has been ſometimes counterfeited with artificial compoſitions, coloured with the true Dragons Blood or Brazil-wood: Theſe are diſtinguiſhed by their either diſſolving in water like Gums, or crackling, and not burning in the fire.

The genuine Dragons Blood is not acted upon by water, or at moſt communicates to it only a ſlight yellowiſh tinge: Laid on a red-hot Iron, it readily melts, catches flame, and emits an acid fume approaching to that of Benzoine. It diſſolves, but not perfectly, in rectified Spirit of Wine, and tinges a large quantity of the menſtruum of an elegant blood-red colour: It diſſolves readily in Oils, and tinges them of a pretty deep red, but ſomewhat leſs beautiful than the colour of the ſpirituous tincture, and conſiderably leſs ſo than that which Anchuſa imparts to Oil.

The ſpirituous tincture ſtains cold Marble of a bright fleſh colour; to warm Marble, it gives a deeper red in proportion to the degree of heat. Mr. du Fay obſerves, that by this one ingredient, with the addition of a little Pitch for the darker colours, all the various ſhades of red may be obtained from the lighteſt to the deepeſt; that it does not ſink near ſo far into cold as into hot Marble, and that the not ſinking is rather an advantage than an imperfection, as the colours which ſink muſt alſo ſpread, ſo as to render the drawing of fine deſigns impracticable; that the beſt way of obtaining beautiful reds from Dragons Blood is, to put the powdered Reſin into Spirit of Wine over the fire, and apply on the Marble with a pencil, the finer part of the ſolution which riſes

CLASS III.

GUMMY-RESINS.

GUMMY-RESINS. THOUGH ſome of the reſinous juices of the foregoing claſs contain a portion of gummy matter, they are not on that account to be ranked among Gummy-reſins. By Gummy-reſins are underſtood thoſe only in which the quantity of Gum is ſo large, as to render the Reſin ſoluble along with it in water by the aſſiſtance of trituration, into a ſeemingly uniform but untranſparent liquor. Theſe ſolutions are only temporary: Upon ſtanding, greateſt part of the Reſin ſubſides again, the liquor becoming clear, and retaining no more than it would have taken up by infuſion or digeſtion. The ſolutions of the common Gummy-reſins obtained by triture, appear of a milky whiteneſs, excepting that of the high-coloured Gummy-reſin Gamboge, which communicates in ſome degree its high colour to the liquor.

I. GAMBOGE. GAMBOGE is brought from the Eaſt-Indies, in large cakes and rolls, ſolid and brittle, of a ſmooth ſurface, perfectly opake, free from any viſible impurities, of a deep reddiſh-yellow colour, equal and uniform throughout its whole ſubſtance. It ſtains the moiſt hands yellow, and makes a beautiful yellow Pigment for the painter (*m*).

This Gummy-reſin has received a variety of names: From the province which affords the largeſt quantities, it is called *Gambogia*, *Cambodia*, *Cambugium*; from the virtues aſcribed to it againſt the gout, *Gummi ad podagram*, *Gummi gutta*; by a corruption of theſe names, *Gummi ghitta*, *Gummi gotta*, *Gutta gamba*, *Gamandra*, *Gemou*, *Cattagenu*, *Catagauma*, &c. from its Gold colour, *Chryſopus*; from its purgative quality, *Succus laxativus*, *Succus indicus purgans*, *Scammonium orientale*, &c. It is ſuppoſed by ſome to be the produce of certain trees, deſcribed and figured in the *Hortus malabaricus* by the name of *Coddampulli*; by others with greater probability, to be obtained from a ſhrubby plant, of the *Eſula* or *Tithymalus* kind: The qualities of Gamboge itſelf ſhew it to be more allied to the juices of theſe kinds of plants, than to thoſe of trees. Thus much is certain, that it is wholly a natural juice, not as ſome have pretended, Scammony or other like ſubſtances, coloured with Rhubarb, Turmeric, or Celandine.

Gamboge when firſt chewed, diſcovers little or no taſte, but ſoon after impreſſes a pungent acrimony and heat, and occaſions a dryneſs in the mouth. It eaſily melts over the fire, and takes flame from a candle: It burns, not as ſome report, with a blue, but with a white flame, and leaves not a black, but a grey

up about the ſides of the veſſel, adding freſh ſpirit in proportion to the evaporation, till the Dragons Blood yields no more tincture.

This Reſin in ſubſtance, has no ſmell or taſte: When diſſolved, it diſcovers a ſlight degree of pungency.

(*m*) *Gamboge--yellow Pigment.*] This Gummy-reſin gives alſo a beautiful and durable Citron-yellow ſtain to Marble, whether rubbed in ſubſtance on the hot ſtone, or applied like Dragons Blood in the form of a ſpirituous tincture When applied on cold Marble, the ſtone is afterwards to be heated, to make the colour penetrate.

a grey aſh. Its reſinous and gummy matter are ſo intimately blended together, that both water and ſpirit, applied ſeparately, diſſolve greateſt part of both: Water acuated with fixed alcaline Salts in moderate proportion diſſolves nearly the whole. Out of ſixteen ounces, rectified Spirit of Wine takes up fourteen; and water out of the ſame quantity, takes up thirteen ounces. The two ounces left by ſpirit, give out one to water; and the three ounces left by water, give out two to ſpirit, the indiſſoluble matter amounting in both caſes to one ounce. This concrete appears therefore to contain more Reſin than Gum. GAMBOGE.

Gamboge is a ſtrong purgative, and oftentimes proves alſo emetic: It is uſed chiefly as an ingredient in cathartic powders and pills for hydropic caſes, in doſes of a few grains. The tincture or ſolution in Spirit of Wine purges more violently than the Gamboge in ſubſtance, eſpecially if inſpiſſated to the conſiſtence of an extract: The watery extract is conſiderably milder; and that made by water impregnated with fixt Alcali ſtill more ſo. An extract made with alcalized water from the matter left undiſſolved by Spirit of Wine, has little or no purgative virtue, but operates powerfully by urine. The orientals are ſaid to prepare an uſeful extract with ſtrong Vinegar.

Sundry additions have been made uſe of for correcting or abating the violence of this medicine, as mineral Acids, Alcalies, eſſential Oils, Stomachics, Spices, neutral Salts, *&c.* But it ſeems more prudent to refrain from theſe kinds of draſtic medicines altogether, than to endeavour to mitigate them by correctors. Mr. Boulduc has given in the French Memoirs, a pretty ſingular correction of Gamboge: He directs the powdered Gummy-reſin to be tied in a linen-cloth, incloſed in a loaf of bread hot from the oven, and kept warm for twenty-four hours, then powdered again, incloſed in a freſh loaf, and this proceſs to be repeated four or five times: By this means, he ſays, the Gamboge loſes its draſtic quality and becomes a ſafe purgative: The crumb of the loaf in which it was firſt digeſted, is found to be ſtrongly impregnated both with the purgative and emetic virtue of the Gamboge. The activity of the Gamboge is doubtleſs by this treatment conſiderably abated; but the ſame end may be obtained by a proceſs ſtill more ſimple, ſtrong coction in water.

II. EUPHORBIUM.

THE ſtalks of the common Spurges bleed, on being wounded, a milky juice, in taſte acrimonious and burning. The EUPHORBIUM plant (ſuppoſed to be ſo called from its firſt diſcoverer Euphorbus, phyſician to Juba, and brother to Antonius Muſa) is nearly allied to the Spurges, in the flowers, the fruit, and the juice: The principal differences are, that the milk of the Euphorbium is more fiery, the ſtalks thick, fleſhy, and angular, with ſharp prickles ſet along the prominent angles.

There are many different ſpecies of the Euphorbium plant, natives of Africa, and preſerved in Europe in the hot-houſes of the curious. Whether the officinal Gummy-reſin of that name is extracted from one particular ſpecies, or from ſeveral promiſcuouſly, is uncertain: It is commonly ſuppoſed to be the produce, chiefly of that called by Breynius *Euphorbium cerei effigie*, &c. Euphorbium reſembling the Cereus or Torch-thiſtle, with thicker ſtalks armed with ſtrong ſpines: What Ray calls the true Euphorbium of the ancients, is the ſpecies deſcribed in the *Hortus malabaricus*, there named *Schadidacalli*, and by

EUPHORBIUM.

by Breynius *Euphorbium Indicum*, &c. that is, Indian Euphorbium reſembling the Opuntia or prickly Pear, with a triangular jointed ſtalk.

The juice is extracted by wounding the ſtem in different parts, pieces of ſheep-ſkin being previouſly tied round near the bottom, to prevent its running down upon the ground: The inciſions are made with a long handled inſtrument, that the operator may receive no injury from the cauſtic liquor ſpurting upon the face, *&c.* The juice concretes into roundiſh, ſemitranſparent whitiſh tears, which for the moſt part are internally hollow: Theſe are the Euphorbium brought to us. We commonly find bits of the ſtalk, prickles, and ſeeds of the plant intermixed, and not unfrequently ſmall ſtones and ſand. The whitiſh or pale yellowiſh tears are preferred, as being the freſheſt; the browner or darker-coloured they appear, the longer they have been kept.

Euphorbium is in taſte extremely acrimonious: The ſlighteſt touch burns and corrodes the tongue: Received in ſmall quantity into the noſe, it occaſions violent ſneezing: The utmoſt caution is requiſite in pulverizing it, to guard the eyes, noſe, and mouth from the pernicious effects of the fine duſt that flies off.

The acrimony of Euphorbium ſeems to reſide in the more ſubtile parts of the Reſin, which are extracted wholly by Spirit of Wine, and almoſt wholly by water, the Reſin and Gum being nearly in equal proportions. An ounce of Euphorbium yielded five drams of ſpirituous extract; and another ounce gave juſt the ſame quantity of watery extract: Both the extracts were like the Euphorbium itſelf, fiery and corroſive, the ſpirituous moſt ſo. The three drams left undiſſolved by ſpirit, gave out two drams to water; and the three drams left undiſſolved by water, gave out two drams to ſpirit, the impurities in both caſes amounting to one dram: Both theſe ſecond extracts had little taſte, even the ſpirituous ſcarcely diſcovered any acrimony till long chewed. Nothing aroſe in diſtillation with either water or ſpirit.

Euphorbium was given internally by the ancients, in very conſiderable doſes, as a purgative, for evacuating water and black bile. No leſs than a ſcruple, a dram, and even two drams, are ſaid to have been taken at once; whereas at preſent, a few grains are found to operate violently both upwards and downwards, to inflame and corrode the ſtomach and inteſtines, and bring on convulſions. In ſome caſes it may be ſafely mixed in very ſmall quantity as a ſtimulus with other purgatives; but by itſelf it is never to be ventured on; nor are the corrections of it with Acids, Alcalies, expreſſed Oils, Gums, *&c.* of much importance. The moſt effectual method of correcting it would be to ſeparate the cauſtic matter by digeſtion in water or ſpirit, and employ only an extract made from the reſiduum by the contrary menſtruum... The principal uſe of Euphorbium is for external purpoſes, particularly in caries of the bones, the Spina ventoſa, ſcirrhous tumours, for taking off warts, as an ingredient in ſtimulating applications and bliſters, and among the farriers. Some employ a mixture of it with a large proportion of Florence Orris-root, or a decoction of it in water as a ſternutatory; a practice by no means to be approved.

THE

III. SCAMMONY

THE plant which produces SCAMMONY is a ſpecies of Convolvulus or Bindweed, with white flowers, oblong triangular leaves, and large thick roots. It was acknowledged by the ancients as a plant of the Convolvulus kind, but Moriſon was the firſt who gave it that name: He calls it *Convolvulus Syriacus & Scammonia Syriaca*; and in this he is followed by Tournefort and later botaniſts. It is a native of different parts of Aſia; that which grows in Syria and the neighbourhood of Aleppo affords the beſt Scammony; that of Smyrna and Myſia an inferior kind. The juice is ſaid to iſſue ſpontaneouſly from wounds made in the root, and to be exſiccated in the ſun or other gentle heat: Some ſuſpect, that it is extracted by expreſſion (*n*).

The

(*n*) *Scammony.*] The publick is obliged to Dr. Ruſſel for an exact drawing and deſcription of the plant which yields Aleppo Scammony, and the manner of collecting the juice, taken upon the ſpot, and communicated in the medical obſervations and inquiries publiſhed by a Society of Phyſicians in London.

The plant, he informs us, agrees in its characters of fructification with the *Convolvulus*, as deſcribed by Linnæus in his *Genera plantarum*, except in the number of ſeeds, which Linnæus confines to two, whereas there are oftener three, and ſometimes four, in the Scammony. The ſtalks are round and pliant, about the ſize of a ſmall gooſe-quill, and run out either on the earth, or on ſhrubs, or on ſuch other ſupport as they meet with, to fifteen or twenty feet or more: From theſe ſpring ſmaller branches, at unequal diſtances, of little leſs extent than the main ſtalks. The leaves grow upon the branches irregularly; they are thin, ſoft, of a bright green colour, about an inch and three quarters broad in the wideſt part, and grow narrower from thence gradually to a point; the part next the ſtalk has on each ſide of the pedicle, two ſemicircular notches or engrailures, one deeper than the other. The flowers grow upon a ſlender erect ſtem, about ſix inches long, divided near the top into two ſmall pedicles, each ſupporting a ſingle flower, of a pale yellow colour, of the ſhape of a bell with its brim turned outwards, and undivided. Theſe flowers begin to be ſent off within about two feet from the root, and continue through the whole length of the plant; their great number and erect ſituation above the leaves affords an agreeable appearance.

The root is generally from three to four feet long, and about as many inches in diameter, covered with a pretty thick aſh-coloured bark. Its inner ſubſtance is of a white colour, and manifeſtly conſiſts of two parts, a number of ſtrong woody fibres running lengthwiſe, and ſmall bundles of veſſels which contain a milky liquor, running in the interſtices of the others. Upon cutting the root tranſverſely, this ſtructure is very viſible, the ſap-veſſels being eaſily diſtinguiſhed by their yellow colour and ſpongy texture; in young roots, the open mouths of theſe veſſels are clearly diſcernible by the naked eye.

This plant grows naturally on all that chain of mountains which extends from Antioch to mount Libanon, and on that part of mount Taurus which is near to Maraaſh; probably it might be found alſo on moſt of the hills in Syria that afford any verdure. It flowers in May; the peaſants collect the Scammony in the beginning of June: Having cleared away the earth from the upper part of the root, they cut off the top in an oblique direction, about two inches below where the ſtalks ſpring from it: Under the moſt depending part of the ſlope they fix a ſhell, or ſome other convenient receptacle, into which the milky juice gradually flows. In twelve hours, the whole of the juice is drained off, to the quantity of only a very few drams from one root. The juice from ſeveral roots is put together, and in a little time hardens into Scammony.

It is the root only that produces this concrete; for the ſtalks and leaves near the root, even when preſſed, afford no ſigns of a milky juice. At the ſuperior extremity of

the

SCAMMONY. The Aleppo or beſt Scammony is in fine, ſmooth, ſomewhat gloſſy maſſes, of a grey colour, a ſpongy texture, not very heavy, eaſily friable, of a diſagreeable ſmell, and a bitter nauſeous taſte: Powdered it appears of a bright grey colour: On the contact of watery moiſture, it becomes milky. The Smyrna or inferior Scammony, the ſort which for ſome years paſt the ſhops have been chiefly ſupplied with, is of a dark blackiſh grey or browniſh colour, more impure, more ponderous, of a cloſe compact texture, and does not appear ſo white when moiſtened. Of either ſort we ſhould examine the internal part of the maſs, particularly of the large ones: I once found a lump of Lead incloſed.

The Aleppo Scammony contains more Reſin and leſs Gum than that of Smyrna. An ounce of Smyrna Scammony yielded with water juſt half an ounce of gummy extract: The reſiduum yielded with ſpirit two drams of Reſin, leaving two drams of impurities undiſſolved. On inverting the procedure, and applying rectified ſpirit at firſt, I obtained from an ounce, two drams and two ſcruples of reſinous extract, and from the reſiduum half an ounce of Gum, the indiſſoluble part amounting here to only four ſcruples. The watery infuſions, whether made from the Scammony at firſt, or after ſpirit had performed its office, were extremely mucilaginous, ſo as to be difficultly reduced to a dry conſiſtence. Nothing aroſe in diſtillation with either water or ſpirit, except that the diſtilled water diſcovered a faint kind of ſmell.

Boulduc informs us, in the French Memoirs for the year 1702, that from four ounces of Aleppo Scammony he obtained one and a half of watery extract, and from the reſiduum two ounces of ſpirituous extract; that from the ſame quantity, he obtained with Vinegar two ounces and two drams of extract, and from the reſiduum, with rectified ſpirit, ten drams; and that on applying rectified ſpirit at firſt, he had three ounces of reſinous extract from four of Scammony.

Scammony

the plant, the leaves and ſtalks when ſtrongly preſſed, do emit a very thin milky liquor; but its quantity is inconſiderable, and according to the beſt obſervation that Dr. Ruſſel could make, its quality is different; for neither the ſtalks, leaves, flowers nor ſeeds ſeemed to have any purgative virtue.

Of this entirely pure Scammony very little is brought to market, the greateſt part of what is to be met with being adulterated, if not by thoſe who gather it, by thoſe who buy it of them, with wheat flower, aſhes, or fine ſand, and ſometimes with ſome other ingredient (poſſibly the expreſſed juice) which makes it very hard and difficult of ſolution. The notion of its being adulterated with the juice of Spurges ſeems to be a miſtake; for the doctor informs us that he has always found the purgative quality to be ſtrongeſt in pure Scammony, and weaker in the adulterated ſorts.

Pure Scammony is light, ſhining when broke, and crumbles with the leaſt force on being rubbed betwixt the fingers. If a wetted finger but touches it, it turns immediately milky; and if broke and put into a glaſs of water, it ſoon diſſolves into a milky liquor of a greeniſh caſt; which, though it lets fall a ſediment after ſome little time, yet ſtill retains its milky colour.

The colour of Scammony ſeems to be no mark of its purity; for the doctor ſays he has ſeen it in all the degrees, from almoſt a jet black to a yellowiſh white, and all equally good. But though it differs ſo much in colour when in large pieces, yet all good Scammony when powdered, is nearly of the ſame browniſh white colour.

The Scammony plant has been raiſed in England, from ſeeds procured by the gentleman from whom this account is taken; and found to flouriſh in the open ground, with all the marks of vigour.

Scammony is one of the more powerful cathartics. Some have looked upon it as being truly virulent, and contrived ſundry methods for correcting or rendering it milder: The only correction now in uſe is expoſing the powdered Scammony to the fumes of burning Sulphur: Thus prepared, it is called *Diagrydium*, (properly *Dacrydion*, i. e. *Lacrymula*) *ſulphuratum*. Neither this, however, nor the other corrections, by treating it with juices of different plants, moiſtening it with Spirit of Vitriol, baking it in a ſcooped quince incloſed in dough, &c. are at all neceſſary. Scammony itſelf, or its pure Reſin in the doſe of ſix grains, duly divided and diſſolved or rendered ſoluble in watery liquors by trituration with Almonds and Sugar, may be given with ſafety where ſtrong kinds of purgatives are required. Extracts made from Scammony with decoction of liquorice, and with water acuated with fixed alcaline Salt, are greatly commended by Boulduc, particularly the latter, as being the mildeſt and beſt preparations obtainable from this Gummy-reſin. SCAMMONY.

ALOES is a bitter juice extracted from the leaves of a plant of the ſame name. The Aloe plant has very juicy, thick, fleſhy leaves, and liliaceous flowers: Many different ſpecies of it grow ſpontaneouſly in the Eaſt and Weſt-Indies, and are cultivated in botanic gardens in Europe. The officinal Aloes is commonly ſuppoſed to be the inſpiſſated juice of the leaves: I hold it to be rather a true extract, or if it is in ſome places prepared by inſpiſſating the juice, yet that this juice is obtained by cutting, bruiſing, and preſſing the leaves. ALOES.

Three ſorts of Aloes are diſtinguiſhed in the ſhops, by the names of *Aloe ſoccotorina*, *ſuccotrina*, or *zoccotrina*, *Aloe hepatica*, and *Aloe caballina*. The epithet *Soccotrina* is taken from the iſland Zocotora, *Hepatica*, from the liver colour, and *Caballina*, from the uſe of this ſpecies being confined to horſes. The Succotrine Aloes is the beſt, the Hepatick next in goodneſs, and the Caballine the worſt. Formerly there was a kind of Aloes called *Lucida*, ſuperior to all the others: This was ſemitranſparent, and doubtleſs prepared from the pure juice extracted without any conſiderable preſſure. At preſent we meet with none of this ſort, and we muſt be contented with the ſuccotrine and hepatic. Theſe differ from one another only in degree of purity (*o*); and even in this reſpect they

(*o*) *Aloes, different in purity.*] The three ſorts of Aloes differ not only in degree of purity, but in ſmell, and appear to be obtained from three different ſpecies of the Aloe plant. The bitter juice reſides in diſtinct veſſels ſpread through the ſubſtance of the leaves; the fleſhy part of the leaf has a glutinous ſweetiſh taſte, with little or no bitterneſs.

The aloetic juice is ſaid to be extracted, by plucking the leaves and ſtroaking them gently downwards, or by cutting and bruiſing them, and ſuffering them to ſtand for three weeks or longer, when the bitter juice is found to have ſeparated, the lighter feculencies ariſing to the ſurface, and the groſſer falling to the bottom. The juices are afterwards inſpiſſated by the heat of the ſun, to the conſiſtence in which they are brought to us.

It is probable, that the Socotorine aloes is prepared by the firſt of theſe proceſſes, and the Hepatic and Caballine by the laſt; and that after ſtanding for the time limited, the juice is ſtrained through hair-cloths. The impurities obſerved upon breaking a lump of Hepatic or Caballine Aloes are hairs and bits of ſkins; but thoſe of the Socotorine are gravel and ſmall ſtones.

ALOES. they are often so much alike, that it is not easy to distinguish them. For pharmaceutical and medicinal purposes, it is indifferent whether we take one or the other, the Hepatic being as good as the Succotrine, provided it is not visibly foul or drossy; at least I have never been able to find any real difference betwixt them in quality. The principal characters of good Aloes are these: It must be glossy, not very black, but brown; when chewed, rubbed or cut, of a yellow colour; compact, but easy to break; easily soluble; of an unpleasant smell, and an extremely bitter taste. Such as is black, firm, and hard to break, we may suspect to be adulterated.

The gummy and resinous matter in Aloes, are very intimately blended together, insomuch that either watery or spirituous menstrua applied separately, dissolve greatest part of both. Out of sixteen ounces of Aloes, rectified Spirit of Wine dissolved near fifteen ounces: From the residuum water took up one dram, about an ounce of impurities being left. On inverting the procedure, and applying water at first, I obtained but thirteen ounces and a half of watery extract, and from the remainder one ounce and a half of resinous: From whence it follows, that Spirit of Wine is the natural menstruum for Aloes, as it dissolves out of sixteen ounces an ounce and a half more than water does. It appears further, that the common opinion, that water extracts all the gummy part and leaves all the resinous, is erroneous, though on this principle depends the common process of washing Aloes, or preparing from it a watery extract, with a view to wholly separate the supposed hurtful Resin. Whether the watery or spirituous extracts are best, can be determined only by experience. I imagine, the difference betwixt them will not be found to be great. Both the extracts and Aloes in substance are purgative; and if used too freely, are apt to occasion great heat and ebullition of the blood, and dispose to hæmorrhoidal complaints.

Aloes is an ingredient in many officinal compositions, particularly in the pills. One of the most common preparations of it is the *Aloe lota* or *depurata*: This is made by digesting or gently boiling good succotrine Aloes with a proper quantity of water, filtering the solution, and inspissating it by the heat of a water-bath to the consistence of an extract, or to such a thickness that it may be fit for making into pills. If this extract (for it is truly such) be made, instead of common water, with the expressed juice of Violet flowers, it is called *Aloe violata*; and with the expressed juice of Rose leaves, *Aloe rosata*. When the *Aloe violata* is mixed with half its weight of Creme of Tartar, the compound is named *Aloe violata tartarea*. If the *Aloe rosata* be dissolved in a good quantity of the fresh juices of Roses, Violets, Borage and Bugloss, mixed in equal proportions, and afterwards reduced by evaporation to its former consistence, the extract thus prepared, is called *Aloe insuccata*, and with the addition of one third its weight of Creme of Tartar, *Aloe insuccata tartarizata*. Aloes extracted with a mixture of distilled Vinegar and Rose-water, and afterwards inspissated, is the *Cholagogue extract* of Andernacus: Treated in the same manner with rectified Spirit of Wine, it yields the resinous extract called *Balsam of Aloes*. If only a moderate quantity of rectified spirit be used for the extraction, the filtered tincture is called with propriety *Essence of Aloes*. Aloes is also the basis of the *Elixiria proprietatis*, several compositions of which may be seen in dispensatories.

dispensatories. The best method of making these preparations is, to extract a tincture from each of the ingredients separately, and then mix the three tinctures together: By this method the elixir will turn out thicker, stronger, and more saturated than when all the ingredients are digested in the menstruum together: It is of advantage also to employ for the menstruum, not a highly rectified but a phlegmatic spirit, especially for the Saffron and Myrrh. ALOES.

It is observable that Essence of Aloes stains the glass wherein it has been kept for some time, of a deep red colour, covering it as it were with a coat of a fine transparent varnish, which no other essence does. Mr. Geoffroy of Paris endeavoured to persuade me, that the red tincture on the glasses wherein Elixir proprietatis is kept, proceeded from the Myrrh and not from the Aloes: But on trying Essences of Myrrh and Aloes separately, the Essence of Myrrh never stained the glass, whilst that of Aloes always did.

Some take the watery extract of Aloes, add to it a portion of *Terra foliata tartari*, and digest the mixture in Spirit of Wine: This preparation is called *Elixir purgans*. If sixteen ounces of Aloes, two ounces of Myrrh, and half an ounce of Frankincense be pulverized, mixed together, and distilled in a sand heat in a low glass body, there arises an Oil called *Oleum Aloes purgans*. The *Angelic* and *Frankfort pills*, of common use as laxatives, consist either of the Aloe violata, or of Aloes mixed with a small portion of other purgatives: Some add a little Scammony, others dissolve the Aloes in an infusion of Sena. Aloes is employed also for external purposes, as a balsamic and vulnerary.

V. OPIUM.

ON wounding the heads or stalks of the Poppy, a milky juice exudes, which exsiccated proves a fine kind of OPIUM. In Natolia, Cilicia, Cappadocia, in the neighbourhood of Cairo, and in several other parts of the Turkish dominions, Poppies are cultivated for this use in fields, as Corn among us. The method of collecting the juice by incision is described by Kæmpfer in his *Amœnitates exoticæ*. This process, however, is now but rarely practised, the consumption of this drug being too great to be supplied by that method of collection. The best sort of the officinal Opium is the expressed juice of the heads, or of the heads and the upper part of the stalks inspissated by a gentle heat: This was formerly called Meconium, in distinction from the true Opium or juice which issues spontaneously. The inferior sorts (for we find considerable differences in the quality of this drug) are said to be prepared by boiling the plant in water, and evaporating the strained decoction: But as no kind of our Opium will totally dissolve in water, the juice is most probably extracted by expression. I have been informed by some Turks at Genoa and Leghorn, that in some places the heads, stalks and leaves are committed to the press together, and that this juice inspissated affords a very good Opium (*p*).

Opium

(*p*) *Opium procured by expression*, &c.] This point has not as yet been fully determined. It is commonly supposed, that whatever preparations the Turks may make from the Poppy for their own use, the Opium brought to us is really the milky juice collected from incisions made in the heads, as described by Kæmpfer. It is certain, that an extract made by boiling the heads, or the heads and stalks in water, is much weaker than Opium; but it appears also that the pure milky tears are considerably stronger.

OPIUM. Opium is brought not only from Turkey, but from Perſia and the Eaſt-Indies, incloſed in leaves; the two laſt ſorts are more impure than the firſt, and greatly inferior in quality. The largeſt quantities come from Alexandria, Smyrna and Aleppo: Some of the dealers in this commodity diſtinguiſh the beſt Opium by the name of *Opium cabaiſenum*, from its coming over in calabaſhes or gourd-ſhells like Aloes and ſome of the Balſams. The principal marks of the goodneſs of Opium are, its diſcovering internally no viſible impurities, its appearing when broke, in ſome degree bright, and of a dark reddiſh-black colour, approaching to that of Aloes, its being dry, not ſoft or unctuous, moderately ponderous and compact, inflammable, of an acrid bitter taſte, and a faint ſmell like that of unripe Poppy-heads, without any thing of an empyreumatic flavour, and its communicating to water not a yellow but a reddiſh tincture.

With regard to the chemical hiſtory of this extraordinary concrete, its component parts like thoſe of other vegetable ſubſtances, have been generally aſſigned from the reſult of deſtructive analyſes by fire; and its truly wonderful, ſoporific and anodyne virtues, aſcribed to principles which naturally have no exiſtence in it, as volatile Salts, Sulphurs, empyreumatic Oils, *&c.* The particular matter on which its aſtoniſhing effects depend, has not hitherto been exhibited in a ſeparate or perfectly pure ſtate; but that matter, whatever it may be, it is in the power of chemiſtry to acuate and concentrate, to obtund and to deſtroy.

The principles ſeparable from Opium are, a Reſin, Gum, a minute portion of ſaline matter, water and earth. The Reſin is of two kinds, one more truly reſinous, of a ſolid conſiſtence, in its nature more fixed, and in its operation more ſluggiſh; the other ſofter and thinner, more volatile, and of much more ſpeedy and powerful activity. The ſaline matter is of the acidulous kind, analogous to the eſſential Salts of other vegetables: Its proportion is ſo ſmall, that it is not eaſily ſeparable in its proper form, though it has ſometimes happened, that actual cryſtals have concreted in a watery ſolution of Opium. The Reſin, the Gum, and the Salt, are very intimately combined together, inſomuch that all the three diſſolve almoſt equally in water and in ſpirit: It is probably to the ſaline principle, in this and other vegetables, that this intimacy of union is in great meaſure to be aſcribed.

Four ounces of Opium, treated with highly rectified Spirit of Wine, yielded three ounces and four ſcruples of reſinous extract: The reſiduum, dried and treated with water, yielded only four ſcruples of gummy extract, five drams and a ſcruple of indiſſoluble impurities remaining. On taking four ounces more, and applying water at firſt, I obtained two ounces five drams and one ſcruple of gummy extract; and by digeſting the reſiduum in Spirit of Wine, three drams and one ſcruple of reſinous extract, the indiſſoluble part amounting here to ſeven drams and a ſcruple. In diſtillation, rectified ſpirit brought over little or nothing; but the diſtilled water was conſiderably impregnated with the particular ill ſmell of the Opium.

The ſubtile ſoft kind of reſinous matter diſcovers itſelf in great meaſure, in the bare watery ſolution of Opium, generally ariſing to the ſurface in form of a fat, unctuous, frothy ſubſtance. This is the ſtrongeſt and moſt active part of

of the Opium; a few grains are ſufficient to kill a dog, who could bear a whole dram of crude Opium. From a pound of Opium, we may collect two or three drams of this balſam-like ſubſtance; but we are not to imagine that this is the whole quantity which the Opium contains: Beſides what thus ſpontaneouſly ſeparates, a part remains combined with the reſt of the juice, and probably is the principle, or the direct ſeat of the principle, that gives activity to the whole. OPIUM.

As Opium in ſubſtance is frequently found to be productive of unfavourable conſequences, different methods have been contrived for correcting or rendering it more univerſally ſafe. In this enquiry, every one has proceeded agreeably to the idea he had formed of the compoſition of Opium, and endeavoured to counteract that principle, in which he imagined its activity to conſiſt: Hence the great variety of pretended correctors. Thoſe who aſcribed its power to a volatile alcaline Salt, thought to mitigate it by acids, as Spirit of Vitriol, dulcified Spirit of Vitriol, Citron juice; whilſt others, deducing its operation from an acid, uſed alcalies for the correctors. Some, preſuming it to be of a cold nature, joined to it hot ſubſtances, as Cinnamon, Pepper, Ginger, Euphorbium, *&c.* theſe kinds of additions accompany it in the ancient electaries, and as moſt electaries formerly received Opium in their compoſition, *Opiatum* became a general name for the form itſelf. Some, imagining Opium to be impregnated with a narcotic Sulphur, endeavoured to diveſt it of that offending principle, by cutting it into thin ſlices, and gently roaſting it till it begun to ſmell agreeably: Others, afraid that this degree of torrefaction was inſufficient for the total diſſipation of the Sulphur, had recourſe to a ſtronger heat, and deſtroyed the Opium and all its powers by burning. On what principle Henbane ſeeds and other ſtupefactive bodies were joined to Opium, it is hard to gueſs.

For my part, I am perſuaded, that the narcotic matter of Opium is diffuſed throughout its whole ſubſtance; but that it reſides moſt copiouſly, and in the moſt eminent degree, in its finer, ſubtile, volatile parts; that theſe parts are capable of being highly concentrated and exalted in their power by art; I know myſelf a certain preparation of Opium, by which a whole chamber full of men may be preſently ſtupefied, and deprived of their ſenſes, and even of their lives alſo, without a ſingle grain being ſwallowed; that the narotic matter cannot be ſeparated in any viſible form, without ſome admixture of the other parts; that Opium cannot be totally freed from it, but by a deſtruction of the Opium itſelf; that it operates nearly in the ſame manner as the vapour of burning Charcoal, or the ſubtile exhalations from fermenting liquors. To diſſipate a part of this ſubtile principle, and thus render the Opium more mild and innocent, I know of no method more effectual than fermentation.

The Opium for this purpoſe, is to be macerated in water without heat, the ſcum which ariſes on the ſurface carefully taken off, the liquor decanted from the undiſſolved part, paſſed through a ſtrainer, ſet in a warm but not cloſe place, with the addition of ſo much Sugar as will diſpoſe it to ferment, in a veſſel covered only ſo as to keep out duſt: By ſtirring the whole well together, when it has ceaſed to ferment, a freſh fermentation may be excited: I have thus continued the proceſs, in England, for three quarters of a year together. When a little

OPIUM. little of the liquor, ſet in a gentle warmth, in a cloſe ſtopt vial, neither burſts the glaſs, nor diſcovers any expanſive force upon drawing the cork, the fermentation is completed: The liquor is now to be ſtrained or filtered, and evaporated to the conſiſtence of an extract. This is one of the beſt preparations of Opium, and was greatly uſed in England during my reſidence there. It differs from Langelot's *fermentum anodynum* in the ſubſtitution of water to Quince juice, and the omiſſion of Salt of Tartar; by which variations, the fermentation ſucceeds better and continues longer, and the reſinous parts are more effectually ſeparated. If this extract is required to be ſtill more mild, it may be diſſolved afreſh in a large quantity of water, and kept for a time ſtrongly boiling in a broad open veſſel (*q*).

As the reſolution of Opium is greatly promoted by heat, we muſt be cautious in the uſe of diſtilled waters and ſpirits in which Opium is an ingredient: We are particularly to avoid making any diſtillation from it when in actual fermentation. A certain phyſician greatly commends a compound Opiate ſpirit as a moſt noble and approved anodyne; and a mixture of Opium with acrid Tincture of Antimony, as a powerful and ſafe diuretic: In another piece, however, publiſhed not long after, thoſe and other preparations of Opium are by the ſame gentleman condemned. There are various extracts of Opium made with Water, Spirit of Wine, Vinegar, *&c.* Wedel ſays, he makes his extract with the Lixivium or Water that remains in the preparation of the *Terra foliata Tartari:* I know of no Lixivium remaining in that proceſs, the *Terra foliata* being obtained, not by cryſtallization, but by the total evaporation of the liquor: Probably he means a ſolution of the *Terra foliata* itſelf.

I ſhall conclude this article with ſome practical cautions, in regard to the uſe of Opium, drawn from experience: (1.) That neither crude Opium, or its reſinous extract ſhould be given by themſelves, in pills or other forms: Starkey's pills are found to anſwer much better than Opium alone. (2.) That the extract I have recommended, be given rather in a liquid than in a dry form, as in the firſt it operates more expeditiouſly and with greater ſafety. (3.) That tinctures or extracts made with rectified ſpirit are moſt prudently abſtained from. (4.) That thoſe preparations are to be uſed with great circumſpection, which have been made by bare digeſtion, or by an imperfect fermentation. (5.) That a very ſmall quantity of my fermented extract, mixed in glyſters, produces excellent effects in convulſive and painful diſorders, particularly in the nephritic colic. (6.) That Opiates in general, as they are capable, when properly exhibited, of anſwering the moſt valuable purpoſes in medicine, ſo on the other hand, when given imprudently, they are apt to be productive of dangerous conſequences where they do not prove directly fatal.

GUM

(*q*) *Correction of Opium by fermentation.*] Theſe kinds of preparations are grown, among us, entirely into diſuſe, and very juſtly. It is a point of primary conſequence, in preparing a medicine of ſuch activity as Opium, that it be always made of equal and certain ſtrength: Fermentation, if it really weakens the power of the Opium (as it probably does) muſt for that very reaſon render its ſtrength vague and impoſſible to be aſcertained. It does not appear, that the corrections of Opium by fermentation or other like proceſſes, do any thing more than what may be equally effected by a diminution of the doſe.

GUM HEDERÆ is commonly ſuppoſed to be the produce of the *Hedera Arborea* or Tree ivy. Lemery ſays expreſsly, that it exudes from inciſions made in the trunk of that plant, and that the peaſants collect it therefrom in Italy, Provence and Languedoc: Pomet affirms, that he has collected it himſelf from the *Hedera* at Montpelier. This account, however, is ſomewhat doubtful. Though I made great enquiry, in my travels, after the parent of this gummy Reſin, I could never procure any ſatisfactory information: All I could learn was, that the greateſt quantities came from the furthermoſt parts of the kingdom of Naples, and from Sicily: Of the plant which afforded it, I could hear nothing; to the botaniſts of Italy, it was unknown. VI. GUM HEDERÆ.

This gummy Reſin is of a bright, tranſparent, reddiſh brown colour, deeper than the Hyacinth, and approaching to that of the Garnet; when reduced to powder, of a ſaffron yellow; of an agreeable aromatic taſte and ſmell. Such is the genuine Gum Hederæ. In the ſhops, we frequently meet with different ſophiſticated mixtures under this name; by theſe probably thoſe authors have been miſled, who deſcribe Gum Hederæ as of a blackiſh colour, of no ſmell, of an acrid aſtringent taſte, too corroſive for any internal uſe, and fit only for external purpoſes, ſuch as the deſtroying of inſects. The true Gum Hederæ has no corroſiveneſs or acrimony, and may be given inwardly with great ſafety, as it frequently was by Stahl, Becher, and many others. It has an advantage above all the other known gummy Reſins, that it does not occaſion any heat or ebullition of the blood; and proves an excellent and ſafe reſolvent and corroborant, in a viſcid ſtate of the juices, in cachexies, chloroſes, and menſtrual obſtructions.

An ounce of choice Gum Hederæ yielded, with rectified Spirit of Wine, five drams and a half of reſinous extract; from the reſiduum I obtained by Water half a dram of gummy extract, and two drams of indiſſoluble matter. Another ounce, treated firſt with Water, gave two drams of gummy extract; and afterwards, with ſpirit, three drams two ſcruples of reſinous extract; two drams and half a ſcruple remaining undiſſolved. The diſtilled ſpirit has a ſlight taſte of the Hedera; the diſtilled Water is conſiderably impregnated both with the taſte and ſmell, and diſcovers on its ſurface a ſmall quantity of eſſential Oil, which is found on taſting to be leſs hot than the other Oils of that claſs.

SARCOCOLLA is a gummy Reſin brought from the Oriental countries: Neither the plant which produces it, nor the place of its production, are with certainty known. The beſt Sarcocolla is in ſmall tears, about the ſize of peas, of a whitiſh or pale-yellowiſh colour, of a ſpongy texture, very brittle or rather crumbly, ſomewhat unctuous, eaſy of ſolution in Water, of no ſmell or only a ſlight reſinous one, of a bitter taſte intermixed with a ſweetneſs like that of liquorice, but upon the whole not very agreeable. The whiter and bitterer, the freſher and better it is. Greateſt part of what we meet with in the ſhops is in a powdery form, the friable tears being probably rubbed into powder in the carriage. We ſometimes find among it large maſſes of a Vermillion red, and others of a browniſh colour, compoſed evidently of ſmaller pieces joined together, with marks on the outſide like the impreſſion from a mat. VII. SARCOCOLLA.

One

SARCOCOLLA. Out of an ounce of Sarcocolla, rectified Spirit of Wine diſſolved ſix drams: Of the remainder, Water took up only two ſcruples; two ſcruples and a half being left undiſſolved. Water applied at firſt to another ounce, diſſolved ſeven drams and a half: From the remainder, ſpirit took up twenty-ſix grains; ſcarcely eight grains being left. The gummy parts therefore prevail, in this concrete, above the reſinous. In diſtillation, neither Water nor Spirit bring over any remarkable ſmell or taſte——The uſe of this gummy Reſin is only as an ingredient in ſome external applications. It has been ſuppoſed to conglutinate wounds, whence its name *Sarcocolla* or Fleſh-glue.

VIII. ASAFŒTIDA, *Sylphium*, *Laſerpitium*, Devils dung, ſo called from its ASAFŒTIDA. ſtinking ſmell, is obtained from a large umbelliferous plant, deſcribed by Kæmpfer as of the Lovage kind, with leaves like thoſe of Peony, and leafy ſeeds like thoſe of Parſnep; growing in Perſia, particularly in the province Chorafaan about Heraat, and in the province Laar near Congo and Diſguun; not in Media, Libya, Syria or Cyrene, though ſome, from an opinion that it was the produce of this laſt country, have called the juice *Succus Cyrenaicus*.

The root of the plant reſembles a large Parſnep, externally of a black colour: On cutting it tranſverſly, the Aſafœtida exudes, in form of a white thick juice like cream, which from expoſure to the air becomes yellower and yellower, and at laſt of a dark brown colour: It is very apt to run into putreſaction, and hence thoſe who collect it, carefully defend it from the ſun. The freſh juice has an exceſſively ſtrong ſmell, which grows weaker and weaker upon keeping: A ſingle dram of the freſh fluid juice ſmells more than an hundred pounds of the dry Aſafætida brought to us: The Perſians are commonly obliged to hire ſhips on purpoſe for its carriage, as ſcarcely any one will receive it along with other commodities, its ſtench infecting every thing that comes near it

The common Aſafœtida of the ſhops is of a yellowiſh or browniſh colour, unctuous and tough, of an acrid or biting taſte, and a ſtrong diſagreeable ſmell, reſembling that of Garlic. From four ounces I obtained, by rectified ſpirit, two ounces ſix drams and a half of reſinous extract; and afterwards, by Water, three drams half a ſcruple of gummy extract; about ſix drams and a ſcruple of earthy matter remaining undiſſolved. On applying Water at firſt, I gained, from four ounces, one ounce three ſcruples and a half of gummy extract. The ſame quantity yielded, with ſtrong French Wine, two ounces and a half and fifteen grains; from which about one fifth may be deducted for the ſolid matter contained in the Wine. Schroder ſays, that Aſafœtida may be diſſolved over the fire in Water, Vinegar, or Wine; but only a part of it can be diſſolved in any of theſe liquors. The ſmell of the Aſafœtida reſides wholly in an eſſential Oil, which ariſes in diſtillation both with Water and ſpirit: Four ounces, diſtilled with Water, yielded above a dram of Oil.

IX. THE plant which produces AMMONIACUM, and the place of its pro- AMMONIACUM duction, are unknown. The beſt Ammoniacum is compoſed of white, whitiſh, or yellowiſh tears baked together into maſſes: The internal parts particularly

are whitiſh: By age it becomes more and more yellow and brown. It eaſily ſoftens and becomes tough betwixt the fingers. Chewed, it diſcovers a biterish, glutinous, not diſagreeable taſte. Its ſmell approaches to that of a mixture of Opopanax and Galbanum: Some reſemble it to that of Caſtor, others to that of Coriander-ſeeds, and others to that of Garlic. AMMONIACUM

It diſſolves almoſt equally in Water and Spirit. Out of an ounce of choice Ammoniacum, rectified Spirit of Wine diſſolved ſix drams: Water, applied to another ounce, took up ſix drams two ſcruples and a half. From the matter left undiſſolved by ſpirit, Water took up five ſcruples and five grains: From that which Water left undiſſolved, rectified ſpirit extracted a dram; the indiſſoluble part amounting in the firſt caſe to fifteen grains, in the latter only to half a ſcruple. In diſtillation, Spirit of Wine ariſes unchanged: The diſtilled Water has ſomewhat of a ſweetiſh taſte, and ſmells a little of the Ammoniacum, but gives no Appearance of any eſſential Oil.

Ammoniacum is accounted deobſtruent; promotes urine; and in large doſes, opens the belly. It is given particularly in obſtructions of the breaſt, in cachectic, hydropic, and apoplectic caſes, from a ſcruple to half a dram: It operates more effectually in a liquid form, as that of an emulſion, than in the ſolid one of pills; but is moſt commodiouſly taken in the latter form. It is ſometimes diſſolved in vinegar: Externally, it reſolves hard ſwellings. It is purified by diſſolving it in Vinegar, Wine, or Water, and ſtraining and inſpiſſating the ſolution.

X. BDELLIUM

BDELLIUM is another gummy Reſin of which we do not know with certainty either the plant or the place of its production: It is ſuppoſed to be the produce of Africa. Lemery and Pomet have given fictitious figures of the plant, as the latter has done of many others. The beſt Bdellium is of a yelowiſh brown or dark brown colour according to its age, unctuous to the touch, brittle but ſoon ſoftening and growing tough betwixt the fingers, in ſome degree tranſparent, not unlike Myrrh, of a bitteriſh taſte, and a moderately ſtrong ſmell. It does not eaſily take flame, and when ſet on fire ſoon goes out: In burning, it ſputters a little, on account of its aqueous humidity, but cannot be ſaid to explode, much leſs to explode like gunpowder, as Hermann and Valentini report.

An ounce of picked Bdellium, treated with Water, gave ſix drams two ſcruples of gummy extract; and afterwards, with Spirit, two ſcruples of Reſin; two ſcruples remaining undiſſolved. Another ounce, treated firſt with rectified ſpirit, yielded two drams of reſinous extract; and afterwards, with Water, five drams two ſcruples of gum; only one ſcruple remaining undiſſolved. The diſtilled ſpirit has no taſte or ſmell of the Bdellium, and the diſtilled Water very little.

XI. GALBANUM.

GALBANUM exudes from an umbelliferous plant with leaves like thoſe of Aniſe, growing in the Eaſt Indies, but moſt plentifully in Syria and Arabia, called by Tournefort *Oreoſelinum Africanum*, *Galbaniferum*, *fruteſcens*, *aniſi folio*. This juice comes over in maſſes, compoſed of white, yellowiſh, browniſh yel-

GALBANUM. low, and brown tears, unctuous to the touch, softening betwixt the fingers, of a bitterish, somewhat acrid, disagreeable taste, and a very strong smell, generally full of bits of stalks, leaves, seeds, and other foreign matters.

Lemery relates a pretty remarkable observation; that Galbanum, Sagapenum, Bitumen judaicum, and Opopanax, substances whose smell is disagreeable to every body, being tied in separate parcels, in the quantity of half a pound of each of the three first, and a quarter of a pound of the last, and kept for some time in a pocket; they impregnated the clothes with a strong and durable musk smell. There are many instances of a mixture of fetids producing an agreeable scent; but I have not found that this mixture is one of them. I have repeated Lemery's experiment in the same manner as he describes it, but not with the same event; and therefore presume that the smell proceeded from some other cause.

Galbanum contains more of a resinous than gummy matter: One pound yields with rectified Spirit of Wine, upwards of nine ounces and a half of resinous extract; but the gummy extract obtained by Water from the same quantity amounts only to about three ounces. The Resin is hard, brittle, insipid and inodorous: The gummy extract has somewhat of a nauseous relish, but could not be distinguished to be a preparation of Galbanum. The whole smell, flavour and specific taste of this juice reside in an essential Oil, which arises in distillation both with Water and Spirit, and gives a strong impregnation to both: From a pound of Galbanum are obtained, by distillation with Water, six drams of actual Oil, besides what is retained by the Water. In this respect, Galbanum agrees with Asafœtida, and differs from Ammoniacum.

The volatility of the active parts of this juice, renders the common method of purifying it, by solution, colature and evaporation, very injurious to it. The smell of the Galbanum is diffused, during the evaporation, over the whole house; and the inspissated matter, whatever menstruum was employed, is found to have lost the distinguishing qualities of the original juice. To prevent as much as possible this inconvenience, the solution should be made in a distilling vessel, and after filtration, inspissated in the same so long at least as the liquor which distils has any smell or taste; after which, the Galbanum may be reduced to a due consistence by further evaporation in an open vessel, and the Oil which arises in the distillation mixed with it. Galbanum may likewise be purified, sufficiently for inferior purposes, as plasters, by exposing it in winter to a strong frost till it grows hard, and then pulverising and sifting it: The woody, strawy, stony, and other like matters will be retained in the sieve.

Galbanum distilled by a strong fire without addition, yields, like other resinous bodies, a large portion of empyreumatic Oil, amounting to upwards of eight ounces upon sixteen: It is remarkable of the Oil of Galbanum, that great part of it appears of a blue colour, sometimes of a deep bright blue, sometimes only of a violet blue. The matter on which the blueness depends appears to be either very volatile or very changeable: It soon escapes or changes in the air, leaving, instead of the blue, a purple colour.

OLIBA-

XII. Olibanum

OLIBANUM, *Thus*, Frankincenſe, comes chiefly from Arabia: But notwithſtanding its early and frequent uſe in fumigations, the plant which produces it is as yet unknown. The ancients diſtinguiſhed various ſorts of Olibanum, as 1. *Olibanum*, or *Thus maſculum*, *Melax*, *Melaſon*, *Teſticulatum*, or the pureſt, yellowiſh white, round tears, which were frequently joined two together. 2. *Thus fœmininum*, or the yellower and more impure. 3. *Thus mammoſum*, or larger oblong roundiſh maſſes, ſomewhat reſembling a woman's breaſts. 4. *Thus granuloſum*, or ſmall granules. 5. *Thus corticoſum*, or ſuch maſſes as have pieces of the bark of the tree adhering. 6. *Thus orobæum* or *Mica thuris*; ſmall fragments, or particles broke off in carriage, *&c.* 7. *Manna thuris*, the finer duſt. 8. *Thus indicum*, or large maſſes, compoſed of different coloured tears, white and blackiſh, joined together.

At preſent only two kinds are diſtinguiſhed: The finer and purer tears are called Olibanum in grains; the more impure fragments and maſſes, common Olibanum, or Olibanum in ſorts. The beſt is of a yellowiſh white colour, ſolid, hard, and brittle: Chewed for a little time, it renders the ſpittle white, and impreſſes an unpleaſant bitteriſh taſte: Laid on burning coals, it yields an agreeable ſmell.

Out of an ounce of the pure tears, rectified Spirit of Wine diſſolved five drams two ſcruples and ſix grains: From the remainder, Water took up two drams and five grains. Another ounce gave out to Water at firſt three drams and a ſcruple; and afterwards to Spirit, four drams thirty-three grains. The indiſſoluble matter, in the firſt operation, weighed twelve grains; in the other fourteen. Both the diſtilled Spirit and Water taſted pretty ſtrongly of the Olibanum, but no ſeparable Oil could be obtained——Olibanum is accounted corroborant, and ſuppoſed to be particularly ſerviceable in diſorders of the head, ſtomach and breaſt. Its principal uſe is in plaſters, unguents, *&c.* and in fumigations.

XIII. Opopanax

OPOPANAX is the juice of an umbelliferous plant called *Panax* or All-heal. It has been generally ſuppoſed to be the produce of the ſpecies, called by Caſpar Bauhine *Panax ſphondylii folio ſive Heracleum*, Hercules's All-heal with leaves like thoſe of the Cow-parſnep: But Ray affirms that it proceeds from a different one, the *Panax paſtinacæ folio*, or Parſnep-leaved All-heal of the ſame author: This laſt is the ſpecies, which Dodonæus raiſed from the ſeeds found among the officinal Opopanax. The juice exudes from inciſions made in the roots and the lower part of the ſtalks. The greateſt quantities are collected in Syria, Bœotia, Macedonia, at Phocis in Achaia, as alſo in Lybia and Cyrene. The plant is found likewiſe in Sicily and Apulia; but we have no Opopanax from thence.

Opopanax, as we commonly meet with it, is of a browniſh colour on the outſide, and paler, inclining to yellowiſh, within; the darker coloured, the older. It is in ſome degree ſoft or unctuous, yet eaſy to break; of a bitter taſte, and a ſtrong diſagreeable ſmell. There are ſome pure, firm, compact tears: But much the greater part is extremely foul, being blended throughout with bits of wood, ſtalks, leaves, *&c.* It is often ſophiſticated; and in Holland, when it is

OPOPANAX. dear, counterfeited by artificial compoſitions. Such as is black, and very ſoft and clammy, ſhould be rejected.

An ounce of Opopanax, treated with rectified Spirit of Wine, gave two drams two ſcruples and ſix grains of reſinous extract; and afterwards, with water, three drams of Gum; two drams and a ſcruple remaining undiſſolved. Another ounce treated firſt with water, yielded three drams two ſcruples and ſix grains of gummy extract; and afterwards, with rectified ſpirit, one dram of Reſin, the indiſſoluble part amounting to three drams and a ſcruple. Both the diſtilled water and ſpirit are impregnated with the flavour of the Opopanax, but no actual Oil can be ſeparated, at leaſt on diſtilling ſmall quantities of the juice.

XIV. SAGAPENUM. SAGAPENUM is a Gummy-reſin of unknown extraction, both in regard to the plant and the place of its growth. When freſh it appears like the other juices, whitiſh: By age, it becomes yellowiſh, browniſh, dark-coloured. Good Sagapenum looks almoſt like horn; it is tranſparent, browniſh on the outſide, whitiſh within, of a ſomewhat acrid taſte, and a ſtrong diſagreeable ſmell, like that of a mixture of Galbanum, Opopanax and Bdellium, with a little Aſa fœtida.

An ounce of the purer ſort, digeſted with rectified Spirit of Wine, yielded five drams and ſix grains of reſinous extract: The remainder boiled with water in a cloſe veſſel, ſo long as it gave out any thing to the menſtruum, yielded five ſcruples and eight grains of Gum: one dram and five grains being left undiſſolved. Another ounce treated firſt with water, gave two drams two ſcruples and a half of gummy extract; and afterwards, with rectified ſpirit, four drams and one grain of Reſin, one dram and ſix grains being left. The diſtilled ſpirit is ſenſibly, and the diſtilled water ſtrongly, impregnated with the flavour of the Sagapenum: Along with the water ariſes a conſiderable portion of actual Oil——This and the preceding Gummy-reſin are employed in medicine, in the ſame caſes as Ammoniacum.

XV. MYRRH. MYRRH is another Gummy-reſin whoſe origin is wholly unknown. It comes immediately from Alexandria, Smyrna and Aleppo, often in large bales of ſeveral hundred weights, incloſed in leather. It is hard, dry, gloſſy, of various colours, yellowiſh, reddiſh, brown, yellowiſh-brown, reddiſh-brown, blackiſh, intermixed with whitiſh ſpecks or tears, tranſparent like Agate, or opake like Pitch, of a peculiar ſtrong ſmell, and a bitter ſomewhat biting taſte. The beſt is that which is of a reddiſh-brown colour, not verging too much to yellowiſh or blackiſh, uniform on the outſide, internally ſpecked or ſtreaked with white, clear and bright, ſomewhat unctuous to the touch, but not tenacious ſo as to ſtick to the fingers.

This Gummy-reſin is liable to great abuſes, the larger maſſes in particular, are frequently no other than ſome artificial compoſition, ſkilfully incruſtated on the outſide with a ſolution of Myrrh. Some report that Bdellium is nearly allied to Myrrh, and not eaſily to be diſtinguiſhed from it: The differences however are ſufficiently obvious, Bdellium being darker coloured and leſs tranſ-

transparent than good Myrrh, internally soft and tenacious which Myrrh never is, yielding a quite different smell, and wanting its bitterness. MYRRH.

From sixteen ounces of Myrrh were obtained by means of water, twelve and a half of gummy extract; and from the residuum by rectified spirit, one and a half of Resin. On treating the same quantity first with spirit and afterwards with water, I obtained five ounces of resinous, and eight ounces six drams of gummy extract. The indissoluble matter amounted in both operations, to two ounces, or one eighth of the Myrrh.

In distillation with water, an essential Oil arises, to the quantity of three drams from a pound. This Oil smells and tastes extremely strong of the Myrrh, and contains all that part in which the peculiar qualities of the juice reside: It differs remarkably from that of the other Gummy-resins, in not being hot or pungent, in being so ponderous as to sink in water, and in not being in the least elevated by Spirit of Wine; highly rectified spirit, distilled from Myrrh receiving no sensible impregnation either in smell or taste.

It is further observable, that whether we digest Myrrh in water or in spirit, the whole of its smell and taste is taken up by the menstruum applied first: An extract made by water after spirit has performed its office, and by spirit after water, are inodorous and insipid. Both the tincture and the extract made by pure spirit at first, contain all the active parts of the Myrrh: The watery infusion or decoction, if made in such a manner as to prevent evaporation, does the same; but on exhaling it to the consistence of an extract, all the flavour of the Myrrh is lost, and nothing but its bitterness remains: No one can distinguish in the watery extract any thing of the specific characters of the Myrrh. From these experiments we learn, in what manner this juice is to be treated to the best advantage, and in what preparations its virtues are preserved or lost.

It is observable also, that on inclosing some powdered Myrrh in the white of a hard boiled egg, and setting it in a moist cellar, the liquor into which the egg is by degrees resolved, extracts nearly all the smell and taste of the Myrrh; that this liquor, commonly called *Oleum Myrrhæ per deliquium*, is precipitated or coagulated by Spirit of Wine; and that the unctuous coagulum, separated from the spirit, dissolves again in pure water. This process has been applied likewise to Mastich and other pure Resins; but from those, as I have found upon trial, the white of eggs extracts nothing, the liquamen not being different from that produced by the egg alone.

Physicians ascribe great virtues to Myrrh, and employ it is a balsamic, antiseptic, attenuant and deobstruent; for promoting expectoration, perspiration, urine, the menstrual and hæmorrhoidal discharges, and the eruption of the small-pox, *&c.*

XVI. TERRA JAPONICA.

TERRA JAPONICA, *Catechu*, Japan Earth, so called from its having been long supposed by the Europeans to be an earthy substance found in Japan, is neither one nor the other. It belongs to the Class of Gummy-resins; being such a combination of gummy and resinous matter, as the extracts made from vegetables by water. In effect it is no other than a preparation of this kind, obtained by inspissating a watery decoction or the expressed juice of the fruit of a certain Palm-tree, growing plentifully on the sea-coasts

TERRA JAPONICA. in Coromandel, Cambaia, Bacaim, Manora, Daman, and ſeveral other parts of the Eaſt-Indies. The fruit, held there as a delicacy, is called *faufe*, its kernel *areca;* and the leaves of the tree *betel:* Hence the names of the plant, *Palma faufelifera*, *arecifera*, &c.

The beſt Japan earth is that prepared by expreſſion, but the greater part of what is brought to us is a true watery extract. There are conſiderable differences in the product according to the manner in which the proceſs has been managed, and the degree of maturity or perfection of the fruit itſelf: That Lime-water, Gum Arabic, Liquorice, Vitriol, or other like ſubſtances are added, is a groundleſs conjecture. Some ſorts are of a pale reddiſh-brown colour, others of a dark blackiſh-brown, or quite black like Bitumen; ſome are ponderous, and others light; ſome compact, and others porous; ſome more and others leſs aſtringent. The beſt ſort is of a dark reddiſh-brown, dry, heavy, hard, compact and gloſſy; chewed, it diſcovers at firſt a bitteriſh ſtyptic taſte, which is followed by an agreeable ſweetneſs.

Japan earth, when pure is almoſt totally diſſolved, its aſtringency at leaſt is totally extracted both by water and ſpirit. Four ounces of the beſt I could procure yielded with water, three ounces and ſix drams of ſolid extract; after which, rectified ſpirit took up no more than twelve grains: The indiſſoluble part conſiſted chiefly of ſand, woody, and other foreign matters. Four ounces of the ſame *Terra Japonica*, treated firſt with rectified ſpirit, gave juſt three ounces of reſinous extract: The reſiduum ſtill yielded with water, five drams two ſcruples and eight grains of a gummy one. Another parcel yielded, on the ſame quantity, two drams more of ſpirituous than of watery extract: But all the ſorts agree in the material points, namely (1.) That the ſpirituous tincture is of a redder colour, brighter, clearer, and more fluid than the watery, the latter appearing browniſh, quite thick, and at laſt curdly. (2.) That the ſpirituous extract inſpiſſated, proves ſtronger, more aſtringent, and more diſagreeable than the watery, the latter poſſeſſing the agreeable ſweetneſs of the *Terra Japonica* itſelf improved rather than injured. (3.) That the extracts made by water after ſpirit, and by ſpirit after water, have no remarkable taſte.

Hence where a ſtrong aſtringent is required, whether for external or internal purpoſes, we are directed to the ſpirituous tincture and extract; and for a milder and more grateful corroborant, to the watery extract. A little of this laſt taken into the mouth at bedtime, and ſuffered ſlowly to diſſolve, proves remarkably ſerviceable in diſorders of the throat.

CLASS IV.

CAMPHOR.

CAMPHOR. THERE are ſundry Indian plants from which CAMPHORS are obtainable, but only two which afford any large quantity, and from which this commodity is commonly prepared, one growing in Sumatra and Borneo, the other in Japan, as particularly about Satſuma. The firſt is called by Breynius *Camphorifera Sumatrana*, &c. the Camphor-tree of Sumatra, with leaves like thoſe of the Clove-tree but longer pointed, a large oblong fruit, and a very

very large cup ſomewhat reſembling a Tulip: The latter, *Camphorifera Japonica*, &c. the Camphor-tree of Japan, with Bay-like leaves, a ſmall globular fruit, and a very ſhort cup. The Camphor of the Japan ſpecies is the only ſort met with in the ſhops, the other being never brought into Europe. This tree is about the ſize of a large Lime, the flowers are white, the fruit is a ſmall red berry. All the parts of it are impregnated with Camphor, but the roots contain moſt: Hence the roots are chiefly made uſe of for the preparation of this commodity, though in want of ſufficient quantities of theſe, the wood and leaves are mixed. CAMPHOR.

The Camphor is extracted by diſtillation with water in large iron pots, on which are fitted earthen heads ſtuffed with ſtraw; greateſt part of the Camphor concretes among the ſtraw in its cryſtalline form, and a part likewiſe paſſes down into the receiver along with the water. It is ſaid by ſome to be extracted by ſublimation without water; but by ſuch a proceſs, it could not avoid receiving from the woody matter, an empyreumatic ſmell, which it is never found to have. The rough Camphor, as firſt diſtilled, looks much like the grey, ſmall-cryſtalled Eaſt-Indian Saltpetre, or like common Bay-ſalt: In this ſtate, it is imported in caniſters, into Europe, particularly into Holland, and there purified or refined. Method of obtaining it.

The refining of Camphor was formerly one of the manufactures of Venice, the Venetians being then the only people in Europe, who traded directly to the Eaſt-Indies. But that trade has long ago paſſed into other hands: The Venetians now import little or no Camphor, and the art of refining it is known only to the Dutch The Engliſh and French import ſome rough Camphor, but ſend it to Amſterdam to be refined, having never been able to ſucceed in the proceſs themſelves. I have been in one of the largeſt refineries, in which there were fifty furnaces, all managed by women; and have ſeen the whole operation after the matter had been put into the veſſels, but no one is permitted to ſee it before. The purification is effected by ſublimation, but doubtleſs ſome additional matter is made uſe of for keeping down the impurities of the Camphor (*r*). The ſublimation is performed in low flat-bottomed glaſſes placed in ſand: The Camphor concretes, in the upper part of the belly of the glaſs into a ſolid cake, which, after the veſſel has been broke, is pared with a knife, and is now the refined Camphor of the ſhops. Gronovius has given a good account of the method of managing the ſublimation. Refining.

Pure Camphor is a dry colourleſs, tranſparent maſs, in appearance reſembling a Salt, ſo light as to ſwim on water, moderately compact, yet eaſy to break, though not reducible by itſelf into fine powder, ſoft, and as it were ſaponaceous to the touch when rubbed betwixt the fingers, of a ſtrong penetrating ſmell, and an acrid aromatic taſte, very eaſily inflammable, and ſo volatile as to exhale totally in a warm air. From theſe properties, it is obvious that Camphor Its general properties.

(*r*) *Refining of Camphor.*] Camphor may be refined by ſublimation without any additional matter. The principal point is the regulation of the fire; which ſhould be juſt ſtrong enough to keep the Camphor ſubliming, and make the upper part of the glaſs ſo warm as that the ſublimate may bake together into a cake. There is a good deal of nicety in hitting this point; and upon the whole, the method pointed out in the following note ſeems to be more commodious.

CAMPHOR. phor cannot be adulterated, much leſs counterfeited, as ſome ridiculouſly pretend, with Tallow, Maſtich, and Spirit of Wine. In order to preſerve this volatile concrete from any loſs in keeping, the ancients covered it with certain ſeeds, doubtleſs with a view to the more effectual excluding of the air: Some have been hence miſled into an abſurd conceit, that the ſeeds poſſeſſed ſome peculiar power of fixing the Camphor; and it is at this time no uncommon practice to put up a few Linſeeds, Pepper corns, &c. along with it. The only method of preſerving Camphor is, to keep it in a cool place ſecured from the air: If tied in papers or bladders, then put into leaden or tin caniſters, or glaſs or earthen veſſels, and ſet in a cool cellar, we need not be afraid of loſing a ſingle grain in many years. I have kept Camphor tied in an ox's bladder, in the heat of boiling water, for an hour, without being able to perceive any ſmell ariſing from it during the coction, or any diminution in its weight.

Uſe in medicine. Camphor, conſidered as a medicine, is a very warm diaphoretic and antiſeptic: It does not however heat the conſtitution ſo much as might be expected from its hot pungent taſte. I have been aſſured by an eminent phyſician, that a ſingle drop of Oil of Cinnamon, though generally containing a little expreſſed Oil, heats more than ten grains of Camphor; and an ounce of ſtrong Spirit of Wine, more than a whole dram——Camphor is employed likewiſe in fire-works, and in ſundry other arts, particularly for varniſhes. Camphorated varniſhes excellently preſerve both animal and vegetable bodies, and peculiarly reſiſt worms and other inſects. Camphor in ſubſtance alſo laid among clothes, preſerves them from moths.

In varniſhes, &c.

Solution in different menſtrua. Camphor diſſolves eaſily and plentifully in vinous ſpirits, and in oils: Four ounces of rectified ſpirit will diſſolve three of Camphor. When thus diſſolved, we need not fear that any part of it will be diſſipated in a warm air, at leaſt till all the ſpirit has exhaled firſt; for if the ſolution be committed to diſtillation the ſpirit will all diſtill before any of the Camphor begins to ariſe (*s*), and even if ſet on fire, the ſpirit will firſt burn away, the Camphor remaining untouched till the ſpirit is all conſumed, and then burning by itſelf with a quite different, ſmoky, ſooty flame. Among the mineral acids, the nitrous diſſolves it moſt eaſily and in largeſt quantity: One part of Camphor diſſolves readily in two of Spirit of Nitre, but requires three of Oil of Vitriol, with the aſſiſtance of digeſtion: The diluted vitriolic acid does not diſſolve it at all; and the marine acts ſo languidly, that it may be doubted whether this acid diſſolves it any otherwiſe than by virtue of a portion of nitrous acid intermixed. Vinegar and other mild vegetable acids, and alcaline liquors have no effect on it.

The nitrous and vitriolic ſolutions afford ſome very diſſimilar phænomena: The Camphor abſorbs the more concentrated part of the nitrous ſpirit, and forms with it a fluid like Oil, which floats on the ſurface: With the vitriolic acid it unites equably into one uniform liquor. To the nitrous acid it ſcarcely gives any tinge, the Oil being but juſt ſenſibly yellowiſh, whilſt the ſolution in the

(*s*) *Diſſolved in ſpirit---the ſpirit diſtils firſt.*] This property affords an effectual and commodious method of purifying Camphor. By diſſolving rough Camphor in rectified Spirit of Wine, its impurities are ſeparated: The ſpirit is recovered by diſtillation; and the remaining Camphor may afterwards be melted into a cake in the bottom of the veſſel, or of another glaſs. The cake eaſily parts from the glaſs upon warming it a little.

the vitriolic acid is at firſt conſiderably coloured, and on ſtanding becomes more and more ſo, changing at laſt to a quite dark reddiſh-brown. The vitriolic acid, if its quantity is large, deſtroys the ſmell of the Camphor, which is not eaſily concealed by any other menſtruum. If water be mixed with the ſolutions made either in Spirit of Wine or in acids, the Camphor inſtantly ſeparates, and reſumes its original appearance and qualities. The addition of Silver or Quickſilver to the nitrous ſolution produces a like effect, the acid letting the Camphor go, and attacking the metal. It is obſervable that no heat or efferveſcence ariſe during the diſſolution of Camphor in the nitrous acid, which raiſes ſo violent a heat and ebullition with eſſential Oils. CAMPHOR.

The principal preparations of Camphor are, camphorated Spirit of Wine, and an Oil of Camphor. The camphorated ſpirit is no other than a ſolution of Camphor in rectified ſpirit. Some have thought to unite the Camphor and ſpirit more intimately together by diſtillation; but that proceſs, inſtead of uniting, ſeparates them. Hoffman and Rothe direct Salt of Tartar to be added previous to the diſtillation, and promiſe, by this method, a camphorated ſpirit, which will mingle with water, without any ſeparation of the Camphor. This indeed the ſpirit will do, for there is ſcarcely any Camphor in it: It is in ſome degree impregnated with the ſmell of that ſtrong-ſcented concrete, but the quantity of actual Camphor that ariſes with it does not amount to above two grains in a quart: No wonder that with ſo ſmall a proportion there ſhould be no ſenſible milkineſs or precipitation. Preparations.

There are ſundry Oils of Camphor prepared by diſtillation. One is made by diſtilling Camphor from red Bole or other loamy earths, and repeating the diſtillation from a freſh parcel of the earth, till the whole of the Camphor is changed into an Oil: This Oil has by ſome been greatly eſteemed, as no Camphor ſeparates from it on the admixture of water. I tried the proceſs with half an ounce of Camphor, and two ounces of powdered red Bole, mixing them well together, and urging them with a gradual fire in a retort: The Camphor aroſe much ſofter than at firſt, and in ſome meaſure unctuous, and on diſtilling it over a ſecond time from the ſame quantity of Bole, about one half of it became fluid. Both the liquor and the ſublimate being mixed with two ounces more of Bole, and the diſtillation repeated, the whole of the Camphor aroſe in the form of a fluid Oil, with a little water, weighing together about an ounce. A part of the inflammable principle of the Camphor appeared to be retained each time by the ferrugineous matter of the Bole, all the reſidua being conſiderably black and ſparkling. Oils of Camphor.

Another Oil of Camphor is prepared by digeſting one part of Camphor with four parts of Oil of Turpentine, and then diſtilling them. Lemery relates, that Camphor and Oil of Turpentine are of the ſame degree of volatility, and that they both diſtil perfectly together. I repeated the diſtillation in freſh retorts ſix times ſucceſſively, but always found a part of the Camphor ſublimed by itſelf: There was alſo another more remarkable ſeparation; a portion of theſe ſubtile volatile bodies remaining every time at the bottom of the retort, and proving ſo fixed as to bear a red heat.

A third Oil of Camphor is made from Camphor and Venice Sope, by diſtillation and cohobation, in the ſame manner as the two foregoing: This is

CAMPHOR. called by ſome *Oleum camphoræ arthriticum*. All the three have ſomewhat of an empyreumatic odour; and conſidered as medicines, are of little or no conſequence. Camphor is one of thoſe drugs which art cannot improve either for medicinal or mechanic uſes; and which are therefore to be given in their entire ſubſtance, or unchanged in their compoſition. All the aſſiſtance that the phyſician can in this caſe expect from the chemiſt, is, to diſcover the moſt commodious means of fitting the ſubject for exhibition.

Fitted for medicinal exhibition. For reducing Camphor into powder, and thus fitting it for ſuch forms as receive powdery ingredients, it ſhould be moiſtened with a few drops of rectified Spirit of Wine, which will render it eaſily pulverable. Some endeavour to impregnate water with Camphor, by ſetting the Camphor on fire and quenching it in water, but this is both an unfrugal and an ineffectual method. The beſt way of obtaining a watery ſolution of Camphor is, to grind it with Almonds, in the proportion of about four ſcruples of Almonds to half a dram of Camphor: By this means the whole of the Camphor will be rendered ſoluble in water into the form of an emulſion. By agitating and grinding it with the yolk of an egg [or with mucilages] it becomes likewiſe miſcible with water: The yolk of one egg is ſufficient for about two ſcruples of Camphor. Sugar, the common intermedium betwixt oily or reſinous bodies and water, anſwers leſs effectually for Camphor, and lets it go much ſooner on the admixture of watery liquors, than either Almonds or yolk of Eggs.

CLASS V.

GROSS OILS.

OILS. THESE kinds of Oils are always artificially extracted, by expreſſion or by coction in water. OIL OLIVE is obtained from the fruit of the

OIL OLIVE. *Olea Sylveſtris* or wild Olive-tree, of which there are large plantations and entire foreſts in Spain, Portugal, Italy, and other warm countries. The pickled Olives are the green unripe fruit: The Oil is prepared from ſuch as is ripe, in which ſtate it appears of a blue colour, and about the ſize of the ſmaller kinds of Plums. It ripens in November and December. The ripe Olives are kept under cover for ten or twelve days, till they begin to grow hot, then ground betwixt two hard ſtones, in the ſame manner as the ingredients for gunpowder, and afterwards preſſed in baſkets made for that uſe. The Oil which runs out firſt, with very little preſſure, is called Virgin Oil, and in effect is the beſt. After the ſeparation of this, the matter is mixed with a large quantity of hot water, the liquor ſtrained off and ſtrongly preſſed out, and this proceſs repeated in ſome places two or three times: The Oil ariſes to the ſurface of the water, and is thence eaſily ſcummed off. Some repeat the grinding, as well as the expreſſion with water, and thus obtain Oils inferior in goodneſs. The beſt Oil Olive is that of Genoa; but the greateſt quantities come from Spain, particularly from Seville.

OIL OF BEN is obtained from the Ben nut, (*Balanus myrepſica, glans unguentaria*) by ſimple expreſſion, nearly in the ſame manner as the Oil of Almonds is commonly extracted. OIL OF BEN, &c.

Oils are expreſſed alſo from different ſubſtances, among ourſelves, for mechanic uſes; as from Nuts, Linſeed, Rapeſeed, Hempſeed, &c. and divers machines have been contrived both for grinding and preſſing the ſubject.

THESE Oils are frequently employed as menſtrua for the virtues of vegetable and certain animal ſubſtances. They readily unite with eſſential Oils, diſſolve Reſins, and by the aſſiſtance of heat, extract thoſe principles from ſuch plants as contain them: The ſubject is commonly boiled in the Oil, till the watery moiſture is diſſipated, which is known from a little of the Oil, when ſet on fire, burning away quietly without ſputtering. But though theſe Oils excellently diſſolve the active parts of many plants, the proceſs is accompanied with one great inconvenience, that all the expreſſed Oils require a ſtrong fire to make them boil, far ſtronger than water does, by which the Oil itſelf receives an ungrateful impreſſion, and the diſtinguiſhing flavour of the ſubject is wholly diſſipated. If we boil an aromatic plant in Oil Olive, we ſhall perceive its ſmell ſtrongly diffuſed through the whole houſe, little or nothing of it being left in the Oil. When theſe kinds of preparations therefore are wanted, they ſhould be made by infuſion with a gentle warmth, or by adding to Oil Olive a ſuitable quantity of the eſſential Oil of the plant. MEDICATED OILS.

THE more tender odoriferous flowers, which yield little or no eſſential Oil in diſtillation, as Jaſmine flowers, Violets, Tuberoſes, Hyacinths, Lilies of the Valley, Roſes, Jonquils, Clove July-flowers, and many others, give out their fragrance to expreſſed Oils with little or no heat: The Oils diſtinguiſhed by the name of thoſe flowers, and uſed as perfumes, are no other than expreſſed Oils impregnated with their ſcent. Theſe preparations are made in Spain, Portugal, and more particularly in Italy; on account of the greater fragrance of the flowers in thoſe warm climates, and the greater plenty of Oil of Ben, which is far preferable for this uſe to other Oils, as it does not grow rancid in keeping, or at leaſt not till it has ſtood for a number of years. PERFUMED OILS.

The general method of preparing them is this. Some fine carded Cotton is dipt in the Oil, and laid in the bottom of a proper veſſel: On this is ſpread a pretty thick layer of the freſh flowers, above theſe ſome more of the dipt Cotton, and thus alternately till the veſſel is full. The whole is then digeſted for a day and night in the heat of a water-bath; after which the flowers are taken out, the Cotton ſtratified in the ſame manner with freſh flowers, and the proceſs repeated till the Oil ſqueezed out from the Cotton, is found to be ſufficiently impregnated with the odour of the ſubject. The digeſting veſſel is either of Tin, with a cover to ſcrew upon it, or of Porcelane, compoſed of two parts, which are cloſely luted together: Moſt of them have an air-hole in the top, which is ſtopt with a doſſil of the oiled Cotton, which retains ſuch of the odorous effluvia as would otherwiſe make their eſcape. Some, inſtead of the Oil of Ben, take the Ben nut itſelf, cut it in pieces, ſtratify it repeatedly

PERFUMED OILS. with the flowers, and then preſs out its Oil; but the Oil thus obtained is greatly inferior in fragrance to the other.

OIL of BAYS. THE OIL OF BAYS, *Oleum laurinum*, is prepared by coction, in Italy, Spain, Portugal, and other warm climates. Freſh Bay-berries, thoroughly pounded, are boiled in water for a conſiderable time; and the fire being then removed, the decoction, after its groſſer parts have ſubſided, laded out of the caldron: When grown cold, the Oil is found ſwimming on its ſurface, of a thick conſiſtence like Butter. The remaining berries are further pounded, preſſed, again boiled in water, and this proceſs ſeveral times repeated. Some keep the ſeveral Oils apart, others make only one ſort, mixing them all together.

PALM OIL. PALM OIL, *Oleum palmæ*, is prepared in the ſame manner, from a fruit about the ſize of a hen's egg, called *aouara*. The tree which produces it reſembles a Palm-tree, and grows in Africa on the Senega river; whence the Oil is called by moſt of the French writers, *Huile de Senega*; by ſome it is named *Huile de Pumicin*. This Oil when freſh, has an agreeable ſmell, and is uſed by the Africans in food, as Butter among us. By age, it becomes firm and hard like Tallow.

OLEUM CACAO. THE OLEUM CACAO, uſed chiefly in pomatums, is obtained alſo by coction and expreſſion, from the Cacao or Chocolate nut, called by the Indians *Cacahuatl*.

OLEUM de KERVA. THE OLEUM DE KERVA, *Oleum kikinum*, or *Oleum ficus infernalis*, is extracted in the ſame manner from the fruit of the *Ricinus*, called *Grana tiglia*.

CLASS VI.

SWEET SALINE JUICES.

I. MANNA. MANNA, ſo called from its having been long ſuppoſed to deſcend in dew from heaven, like that with which the Iſraelites were fed in the wilderneſs, has been inconteſtably proved to be the proper native juice of the tree upon which it is found. The tree covered with clothes, a branch cut off and carried into a cellar, have continued to bleed Manna as freely as when expoſed to the open air and dew.

From different vegetables. In Perſia and Syria, a ſpecies of Manna exudes in hot weather, from a prickly ſhrub, called by Tournefort *Alhagi maurorum rauwolfii*, by Caſpar Bauhine *Geniſta-ſpartium ſpinoſum foliis polygoni*. This is ſaid to be leſs purgative than ours, and not to keep above a year, whereas ours, if preſerved in a proper place, continues good for at leaſt five years.

Dr. Grim and Dr. Helbig, in the *Ephemerides naturæ curioſorum ann.* 1. give an account of a ſubſtance in appearance, conſiſtence and taſte, reſembling Manna, found upon certain trees in Ceylon and the Eaſt-Indies: But as this ſubſtance

ſubſtance is ſaid to be prepared by inſects, it may perhaps be more properly looked upon as a concrete Honey than a Manna.

In Dauphiny, Provence, and ſome others of the ſouthern parts of Europe, a Manna exudes from the Turpentine and Larch trees, but in ſmall quantity, and not eaſily to be collected pure.

Different kinds of the Manna of the Aſh tree.

The common Manna of the ſhops is the produce of a ſpecies of the Aſh-tree, *Fraxinus rotundiore folio*, *C. B.* growing in Naples and Sicily, particularly in the province of Calabria. The juice exudes ſpontaneouſly, in the hot dry weather of June and July, upon the leaves, the branches, and the trunk of the tree; that collected from the leaves is called *Manna di fronda*, from the branches *Manna di ramo*, and from the trunk *Manna di corpo*: This diſtinction is of little importance, as the juice is always the ſame whatever part of the plant it iſſues from, as much ſo, as the blood drawn from different parts of an animal body. Theſe ſpontaneous exudations are the fineſt, whiteſt, and pureſt Manna, being naturally filtered and ſecreted from the groſſer parts: But if there was no other, Manna would be rare. When nothing more will exude, the bark is wounded with knives; upon which the juice iſſues more copiouſly, but of a yellowiſh colour, and a groſſer and thicker conſiſtence. In dry weather the Manna ſoon concretes, and is then ſcraped off, to make room for the juice that is to follow. The Manna thus collected is called *Manna ſforzata*, or forced Manna. As watery moiſture would diſpoſe it to ferment, and turn ſour or mouldy, it is further exſiccated by the ſun's heat, or in a warm room; but ſufficient care is taken not to diminiſh its weight too much by making it thoroughly dry.

Thoſe who purchaſe this commodity at the firſt hand, divide it into four ſorts; *Manna granata*, or Manna in ſmall grains; *Manna maſtichina*, or Manna in larger grains like Maſtich; *Manna cannellata*, or *electa*, or ſuch as is in fine, pure, long pieces; and *Manna commune*, or the ordinary foul Manna. In the ſhops, only the two laſt are diſtinguiſhed.

Deſcription of the beſt ſort.

Fine Manna is in oblong, roundiſh, ſingle pieces, moderately dry, of a whitiſh or pale yellowiſh colour, internally compoſed as it were of fine capillary cryſtals, a proof that the juice has been exſiccated by a very gentle warmth. The ordinary kind is of a darker yellowiſh colour, inclining to brown, mixed with particles of wood, leaves, and other impurities, in irregular lumps, generally moiſt. The whiteneſs, dryneſs, lightneſs, purity, cryſtalline appearance upon breaking, and ſweet taſte, are the beſt marks of the goodneſs of Manna.

Sophiſtications.

Manna is often counterfeited or ſophiſticated with other ſubſtances, particularly Sugar and Starch. Theſe may be diſcovered by diſſolving the maſs in water, and inſpiſſating the ſolution, when the adulterated ſorts will turn out far more clammy and tenacious than the genuine, and quite different from it in appearance. Sugar may likewiſe be diſtinguiſhed in good meaſure by cryſtallization: If the ſtrained ſolution be evaporated to the conſiſtence of a thick ſyrup, and then ſet in a cloſe warm place, a part of the Sugar will generally concrete into Candy. There are ſome ſorts of Sugar however, which do not eaſily ſeparate in this proceſs from the Manna, but remain permanently united with it. The ſingular phænomena which I have diſcovered in treating this

MANNA. concrete with Spirit of Wine, afford more commodious and more certain criteria of its genuineneſs.

Purification by Spirit of Wine. Manna, dried a little, diſſolves in rectified Spirit of Wine. The filtered ſolution ſet in a gentle digeſting heat, throws off near five-eighths of the original quantity of the Manna, all over the bottom and ſides of the glaſs: The part thus ſeparated, is as it were the quinteſſence of the Manna: It is of a fine white colour, light, ſpongy, in ſome degree cryſtalline: It inſtantly melts upon the tongue, like ſnow in warm water, and impreſſes an agreeable ſweet taſte, without any thing of the ungrateful reliſh obſerved in the Manna at firſt. If the remaining liquor be gently exhaled a little, and at times ſet by again, there precipitates about one fourth the quantity of the Manna employed: This reſembles in appearance ordinary Manna, but taſtes more agreeably, and diſſolves pretty readily in the mouth, though not near ſo much ſo as the foregoing. On ſtill further evaporating the liquor, we obtain a thick extract, of the conſiſtence of a Balſam, which can ſcarce be fully exſiccated, but continues moiſt, and greatly reſembles in appearance Civet grown brown by age: In this extract, whoſe quantity is about one eighth, reſides all the nauſeous matter of the Manna: It has indeed a degree of ſweetiſh taſte, but blended with a diſguſtful one.

Treated with water. On diſſolving Manna in water, and ſlowly exhaling the ſolution, no ſeparation is made: The whole quantity of the Manna is recovered, unchanged, except that the colour proves ſomewhat darker.

by diſtillation. In diſtillation, Spirit of Wine brings over nothing: The diſtilled water taſtes ſomewhat differently from pure water, but does not appear to poſſeſs the purgative quality which ſome have aſcribed to it, though it is certain that Manna loſes of its cathartic virtue by much boiling. Some report, that water diſtilled from a mixture of Manna with twice its weight of Nitre, taſtes like Bitter Almonds, and have given to the liquor the name of *Manna meteorizata*. I have repeated the experiment with great care, but could not perceive the leaſt degree of any ſuch taſte in the diſtilled water.

By deſtructive diſtillation in a ſtrong fire, a pound of Manna yielded twelve ounces two drams of a phlegmatic liquor impregnated with acid and with a fetid Oil; as alſo two drams and a ſcruple of an empyreumatic Oil diſtinct or in its proper form: The remaining coal weighed three ounces and one dram. The acid ſpirit has been ſaid to diſſolve Gold: This preſumption probably proceeded from thoſe philoſophers, who imagined a certain aereal ſpirit to be the radical menſtruum of Gold, and Manna to be an aereal production largely impregnated with that ſpirit: The acid ſpirit of Manna, however concentrated, has no action on Gold, nor any other powers different from thoſe of the common acetous acid.

by fermentation. Lemery has given ſome experiments on Manna in the French Memoirs for the year 1708: He obſerves that when fermented with water, it yields a weaker and leſs agreeable liquor than the Mead made with Honey; that two pounds of Manna yielded, after fermentation, eight ounces of a weak vinous ſpirit, which afforded only one ounce and a half of rectified ſpirit; that the reſiduum, ſet by to four in a warm place, for a year and a half, gave ſeven drams of an eſſential Salt, which was white, hard, brittle, and cryſtallized into the form of needles.

needles. This Salt is to be looked upon as of the Tartar kind; not as being extracted, but produced, from the Manna.

MANNA.

Its medical qualities.

Manna appears upon the whole to be a juice of the ſame nature with Honey and Sugar; being like them ſweet, inflammable, ſoluble in Water and in Spirit, fermentable ſo as to yield a vinous liquor and ſpirit, a Vinegar and Tartar, &c. It poſſeſſes alſo, like them, a laxative quality, but in a greater degree.

Manna is one of the mildeſt and ſafeſt purgatives, for children and weak perſons, in coughs and obſtructions of the breaſt, where mineral Waters do not freely paſs, in caſes where the ſtronger cathartics cannot be borne. It has one inconvenience, being apt to occaſion flatulencies and ſlight gripes: This may be remedied by carminative additions.

II. SUGAR.

SUGAR is the eſſential Salt of a ſpecies of Reed or Cane (*Arundo ſaccharifera C. B.*) growing ſpontaneouſly in Africa and Aſia, and cultivated in large quantity in the Engliſh, French, and other European ſettlements in the warmer parts of America, where all our Sugar is prepared. A kind of Sugar is obtained likewiſe in the Eaſt Indies from certain trees and other vegetables; and ſome of our own plants alſo afford a ſaccharine concrete (*r*).

The

(*r*) *Sugar from certain trees, &c.*] In ſome parts of North America, particularly in Canada, a kind of Sugar is prepared from the juice which iſſues upon wounding or boring certain ſpecies of the Maple-tree, one of which is named from hence the Sugar-maple; as alſo from the wild or black Birch, the Honey-locuſt, and the Hickery. The Maple is moſt commonly made uſe of for this purpoſe, as being the richeſt, and as beſt enduring the long and ſevere winters of that climate. The juice is boiled down, without any addition, to a thick conſiſtence, then taken off from the fire, kept ſtirring till its heat is abated, and ſet in a cold place; where the Sugar quickly concretes into grains, reſembling common brown powder Sugar.

The trees are tapped early in the ſpring, about the time that the Snow begins to melt: It is obſervable, that when the weather begins to grow warm, they bleed no more; and that after the bleeding has ſtopt, they begin to run again upon covering the roots with ſnow. The more ſevere the winter has been, the juice is found to be the richer and in greater quantity. The trees which grow on hills or high lands yield a richer juice than thoſe which are produced in low countries; and the middle aged than the young or the old.

Mr. Kalm informs us, in the Swediſh tranſactions for the year 1751, that one tree, if the ſummer does not come on haſtily, will yield about forty-two gallons of juice, (Engliſh Wine-meaſure,) and that the quantity which iſſues in one day is from three to ſix gallons: That eleven gallons of juice of middling quality give a pound of Sugar, and that ſometimes a pound has been gained from three gallons and a half: That two perſons can in one ſpring prepare commodiouſly two hundred pounds. He obſerves that this Sugar is weaker than that from the Sugar-cane, but that for ſome purpoſes it anſwers better, as for Chocolate and Preſerves. It is likewiſe eſteemed more medicinal: Conſiderable quantities are brought annually into Europe, particularly France, and there employed in diſorders of the breaſt. It is reckoned that a pound of common Sugar goes as far in ſweetening as two pounds of Maple Sugar.

The large Maple, commonly called Sycamore-tree, bleeds alſo in Europe a ſweet juice, from which an actual Sugar has been prepared. In the Tranſactions above-mentioned, for the year 1754, there is an account of ſome experiments made in this view upon the Swediſh Maple. Eight trees, none of them under thirty years, bled,

SUGAR. The Sugar-cane ariſes to the height of five or ſix feet: It has long leaves, ſharp at both ends; and produces in the middle a kind of arrow, bearing ſilver white flowers: It ſends out ſuckers from the roots, by which the plant is propagated. When the Cane is ripe, it is cut down, cleared from the leaves, and its ſweet juice forced out by paſſing betwixt wooden rollers: In one mill there are commonly three rollers, placed perpendicularly, and turned by Water, by wind, or by cattle. The juice is conveyed from the mill, along a trough or ſpout into the boiling-houſe, either immediately into the boiler, or into a reſervoir: It will ſcarcely keep above a night, without fermenting, and turning ſour, or producing a portion of inflammable ſpirit, ſo as to be apt to take fire in the boiling, and endanger the whole building: Hence the neceſſity of boiling it down into Sugar as faſt as it is preſſed out from the Cane.

History of its preparation.

This juice contains a large quantity of impurities, conſiſting partly of a groſs unctuous and herbaceous matter, ſeparable by colature, and by deſpumation during the boiling; and partly of an oily ſubſtance more intimately blended, ſo as to require for its ſeparation certain additions, as alcaline ley, and more particularly Lime-water: Without theſe additions, it never aſſumes the form of a concrete Salt or Sugar, yielding only a ſoft unctuous extract, which cannot be reduced to perfect dryneſs without ſuch a degree of fire as renders it fetid and empyreumatic. After the firſt boiling and deſpumation, the juice is emptied into other coppers, a quantity of a ley, made from wood-aſhes or from aſhes and Quick-lime, added to it, and the coction and clarification continued. When, towards the end of the inſpiſſation, it riſes up, ſo as to be ready to run over the veſſel, the addition of a little oil occaſions it quickly to ſubſide again: It is obſervable, that if Oil, or Citron juice, were added in the firſt boiler, the Sugar would never concrete or part from its impurities. The Sugar, thus obtained, is far from being pure: It is the common brown Muſcovado. This is further refined by diſſolving it afreſh, boiling with Lime-water and ley, and clarifying with oxes blood (*s*): The Sugar-refiners

bled, in four days, fourteen gallons of juice, which inſpiſſated gave two pounds and a half of brown Sugar. Another time, the ſame eight trees bled, in three days, ten gallons and a half, which yielded one pound four ounces of Sugar, with half a pound of Syrup. It is the Saccharine juice of the Maple-tree, which, exuding upon the leaves, renders them ſo apt to be preyed upon by inſects.

The common Birch bleeds alſo a large quantity of a ſweetiſh juice, which yields on being inſpiſſated a ſweet ſaline concrete, not however perfectly of the Saccharine kind, but ſeeming to approach more to the nature of Manna.

There are ſundry other vegetables, raiſed in our own country, which afford Saccharine concretes; as Beet-roots, Skirrets, Parſneps, Potatoes, Celeri, red Cabbage-ſtalks, the young ſhoots of Indian Wheat. The Sugar is moſt readily obtained from theſe, by making a tincture of the ſubject in rectified Spirit of Wine; which when ſaturated by heat will depoſite the Sugar upon ſtanding in the cold.

(*s*) *Refining of Sugar.*] The author has here overlooked an eſſential part of the proceſs. The Sugar, diſſolved in Lime-water, clarified, and boiled down to a due conſiſtence, is poured into a conical earthen mould, having a ſmall aperture in its lower narrow part ſtopped with a plug. When the Sugar has concreted into a maſs, the liquid part is drained off by the aperture; and ſome fine

refiners at Orleans in France and in England uſe whites of eggs for the clari- SUGAR.
fication, particularly in making the fine Sugar. By repetitions of this proceſs, the Sugar becomes purer, whiter, of a cryſtalline appearance, but proportionably leſs ſweet. A ſyrupy matter ſeparates in the purification, called from its honey-like conſiſtence Melaſſes or Melazzo: From this are produced, by fermentation, the common inflammable ſpirits, diſtinguiſhed by the name of Melaſſes Spirits. In America, the ſcummings alſo, and other refuſe parts of the juice, are fermented for vinous liquors and Rum.

Sugar appears to be a Salt of the acid kind, ſaturated with earthy and oily matter, on which its ſweetneſs depends; hence the diminution of its ſweetneſs in proportion to its purification or the ſeparation of the Oil. Diſtilled by a gradual fire, without addition, it yields, on the pound, about ſix ounces of acid ſpirit, and two ſcruples and a half, or a dram, of empyreumatic Oil. Gently roaſted, it acquires a reddiſh brown colour, and in this ſtate, is uſed for colouring vinous and ſpirituous liquors yellow. By fermentation it yields an excellent kind of Wine; and by a continuance of the proceſs, Vinegar. Chemical properties.

With regard to mixture with different ſolutions and other liquors, it is perfectly neutral; making no alteration in thoſe which by acids or by alcalies would be precipitated or have their colour changed. It renders eſſential Oils, Balſams, Reſins, miſcible with watery liquors: Hoffmann obſerves that when added to milk, it prevents the ſeparation of its oily or butyraceous part. From this property he ſuppoſes the dietetic uſe of Sugar to be fattening, as it renders the unctuous or fat parts of the food miſcible with the animal juices: I have known however many people, who uſed Sugar in abundance, and yet were lean. It diſſolves in rectified Spirit of Wine by the aſſiſtance of heat; but is ſcarcely acted upon by that menſtruum in the cold (*t*).

Many

fine Clay, ſoftened with Water into a paſte or batter, is ſpread upon the upper broad ſurface: The moiſture of the Clay, ſlowly imbibed by, and percolating through the Sugar, carries down with it great part of the remains of the treacly matter. The clayed Sugars, brought from America, are made from the juice directly, without a ſecond ſolution; the liquor being more carefully depurated in the boiling, than when intended for brown Sugar.

Sugar-candy is a cryſtallization of Sugar; prepared either from the brown or the white. The perfect cryſtallization of Sugar is not to be effected, like that of many other Salts, by evaporating the liquor in which it is diſſolved, till a pellicle forms on the ſurface, and then ſetting it in a cold place; but by boiling down the ſolution till it is almoſt thick before it is removed from the fire, and afterwards continuing a conſiderable heat, till the cryſtallization is completed. The Sugar is diſſolved in Lime-water, and when evaporated to a proper conſiſtence, poured immediately into pans, in a ſtove or hot room, whoſe air is ſo hot as not to be ſupported by animals for any conſiderable time: The cryſtals concrete upon ſmall ſticks, which are placed acroſs in the pans for that purpoſe.

(*t*) *Solubility in Spirit.*] Rectified Spirit of Wine diſſolves, by a boiling heat, about one twelfth its weight of fine Sugar; if the ſolution be ſuffered to ſtand for a few days in the cold, the Sugar gradually ſeparates, and concretes into elegant cryſtals. On this principle depends the method of extracting Sugar from ſweet Vegetables by means of Spirit of Wine: Water diſſolves the ſaccharine parts of the ſubject more readily and more copiouſly than ſpirit does, but it keeps them permanently diſſolved, and intermixed with the gummy or other matter which it had extracted at the ſame time; whereas pure ſpirit depoſites the Sugar, and keeps the reſinous or oily principles diſſolved.

SUGAR. Many of the Indians employ Sugar inſtead of Salt for preſerving proviſions, which it does effectually, without communicating the unſalutary qualities of ſalted meats: The Sugar may be waſhed out, inſpiſſated, and uſed for the ſame purpoſes again. From this property it has been employed by ſurgeons, as a balſamic and vulnerary.

CLASS VII.

Juices collected from Vegetable Subſtances by Animals.

I. HONEY.

HONEY. THE HONEY and Wax, gathered by the Bee, are truly Vegetable Juices. Honey is collected from the bottoms of flowers, many of which diſcover a conſiderable ſweetneſs to the taſte. Among the flowers which yield the moſt, are thoſe of Thyme, Roſemary, Lavender, Cowſlips, Primroſes, Marjoram, Baſil, Violets, Roſes, Clove-july flowers, Sage, Balm, Betony, Lilies, the dead Nettle, Sloe-buſh, *&c.* Bees are uncommonly fond of the Lime-tree, the Privet and Phillyrea. In Lithuania, there are large quantities of wild Bees, who lodge in hollow trees in woods, and collect their Honey chiefly from the Lime: Hence, when the ſeaſon happens to be unfavourable at the time of the blowing of the Lime, a ſcarcity of Honey follows. Bees love agreeable ſmells; and are offended by fetids, as Feverfew, Garlic, Onions, Tobacco, *&c.* They love green and yellow colours, and are offended by black and red.

Whether different in different flowers. The ancients judged of the goodneſs of Honey from the flowers which the bees had to collect it from: That of Lilies and Roſes was eſteemed the beſt. At preſent, the Honey of Narbonne in France is held to excel all others, on account of the Roſemary which there abounds. It is not to be ſuppoſed however that the Bee confines itſelf to one particular flower: Nor does it appear, that the Honey collected from one kind of flower differs eſſentially from that which is the produce of another; the only difference being in the quantity, colour, or ſome ſlight flavour from the flower. I have ſeen excellent Honey produced where nothing grew but nettles and other weeds.

Its different ſorts. We meet with Honey of different degrees of conſiſtency and colour; fluid and ſtiff; dark brown, dark yellow, gold yellow, pale yellowiſh and white. The beſt is that which is of a yellow or pale colour, clear and tranſparent, neither quite ſtiff nor quite fluid, eaſily and totally ſoluble in cold Water, of an agreeable ſmell, and a pure ſweet taſte: Such as betrays any particular flavour, does not eaſily diſſolve, or depoſites any ſediment, we may ſuſpect of ſome foreign admixture. Some think to improve their Honey, by communicating by art what the Honey of Narbonne is imagined to receive from nature, a Roſemary flavour. Others dilute thick Honey with Water, and mix meal with the thin. The browniſh and dark brown are generally very impure. The whitiſh, and the granulated, or that which diſcovers cryſtalline particles, more ſlow of ſolution than the reſt, are not to be rejected: They are both good kinds of Honey, provided they are pure from other admixtures——

tures——The manner in which the Honey is extracted from the comb occa- HONEY.
ſions ſome differences in its quality. That which iſſues ſpontaneouſly upon cutting the combs and thus laying open the cells, is the beſt: Such as is forced out by preſſure is of an inferior kind; and the worſt of all is that extracted by Water: The two laſt contain much of the waxy and other matter of the comb. The Honey gathered by young bees, in the firſt year, and ſeparated from the combs without heat or preſſure, is that properly called Virgin Honey: In the ſhops, the finer ſorts in general are diſtinguiſhed by this name.

Honey was the earlieſt ſweet employed for medicinal or domeſtic uſes; the art of preparing Sugar being but of late diſcovery. It differs from Sugar chiefly in its conſiſtence, never aſſuming a concrete or ſolid form (*u*), and its poſſeſſing a greater laxative, expectorant and detergent quality. It is obſervable that ſome have a peculiar averſion to its uſe, and cannot bear it even externally. In the ſhops, it is employed as the baſis of ſome electaries, medicated Honies, Oxymels, *&c.* which may be ſeen in diſpenſatories. It is purified from waxy, farinaceous and other like matters, by liquefying it in a gentle warmth, taking off the ſcum which ariſes to the ſurface, and paſſing the Honey through a linen cloth. It ſhould never be boiled, as its finer and more ſubtile parts are in that proceſs diſſipated; and an ungrateful impreſſion made upon it by the heat. The liquor which ariſes even in the heat of a Water-bath is manifeſtly impregnated both with the ſmell and taſte of the Honey: It amounts to three ounces upon eight of Honey. The Honey thus inſpiſſated diſſolves, as at firſt, both in Water and in rectified Spirit of Wine, only a ſmall portion being left. The vapour which exhales in the boiling, takes flame from the approach of a candle, diffuſes its ſmell throughout the houſe, and will draw together a whole ſwarm of Bees from a great diſtance. In diſtillation by a gradual fire without addition, thirty-two ounces of Honey yielded upwards of twenty-four of an oily acid ſpirit, with a little empyreumatic Oil: The remaining coal weighed upwards of ſeven ounces, and like that of Manna, could ſcarce be reduced into aſhes. The acid ſpirit has been ſaid to diſſolve gold and quickſilver; but I have not obſerved it to have any action on either of theſe bodies, or to differ in its diſſolving power from the acid of Vinegar. Nor does there ſeem to be any foundation for the virtue commonly aſcribed to this ſpirit and to the diſtilled Water of Honey, of making hair grow. The principal conſumption of Honey is in ginger-bread, and for making Mead and Metheglin. Thirty-ſix ounces of Honey, diluted with four quarts of warm Water, and fermented with a little yeaſt, yielded on

Its uſes, and chemical examination.

(*u*) *Concrete form.*] Though Honey does not concrete into a cryſtalline or ſaline maſs by the uſual methods of evaporation and cryſtallization; I have nevertheleſs made it to aſſume that form by a variation of the proceſs; by treating it in the manner practiſed for the refining of Sugar. The Honey, clarified and boiled down to a due conſiſtence, and then poured into a conical mould perforated at the bottom, concretes into a ſolid maſs, and diſcharges a liquid treacly matter. The lump, at firſt browniſh or yellowiſh, by ſpreading moiſt clay upon the ſurface becomes white: It is moderately firm, of a cryſtalline appearance, and a very ſweet taſte, different from that of Sugar, and not quite the ſame with that which the Honey had at firſt.

HONEY. on diſtillation a pint of phlegmatic ſpirit, which by rectification was reduced to eight ounces.

II. BEE-GLUE. THE bees employ in building their combs two kinds of ſubſtances, one, a ſoft, unctuous, glutinous matter, the other, Wax. The firſt ſerves as a Glue for cementing the combs to the hives, and cloſing up the cells: Hence it is called BEE-GLUE. A portion of this commonly adheres where the bees alight, and may be ſcraped off from about the entry of the hive: It was formerly kept in the ſhops under the name of *Propolis*, but is now entirely in diſuſe.

III. WAX. WAX is collected from leaves and flowers, particularly from thoſe flowers which are well furniſhed with ſtamina, or threads bearing little knobs on the top: The ſtamina of the common Poppy and Rocket yield to the bee abundance—

Whence procured. In the *Ephemerides naturæ curioſorum* there are two accounts of a little waxy matter being obtained in beating Roſes. In ſome parts of America, a kind of Wax is collected from trees.

Wax is at firſt white, as we ſee in the cells of young bees: The yellow colour which it acquires afterwards is ſuppoſed by ſome to proceed from the Honey. This colour is not permanent: By kneading the Wax, or by long keeping, it loſes its lively yellow and becomes whitiſh: Melted by common fire, it turns darker coloured, but by expoſure to the ſun it grows at length white as ſnow. Thoſe who bleach Wax for candles and other uſes, caſt it into

Method of whitening, thin plates by melting and pouring it upon a roller turning round in cold water, and ſpread the fine ſhivers into which it is thus divided, upon a linen cloth, in the ſun: When the outſide is ſufficiently whitened, the Wax is melted and caſt into thin plates again, that a freſh ſurface may be expoſed to the ſun, and this proceſs three or four times repeated. The bleaching is begun and ended with the warm part of the year——The Wax is procured at firſt by melting over a gentle fire, the matter left after the expreſſion of the Honey, ſcumming off the lighter impurities which ariſe to the ſurface, and pouring it into a moiſt wooden veſſel: When the cake of Wax congeals, the groſſer part at the bottom is pared away.

examined by menſtrua and diſtillation. Bees-wax, when in perfection, is of a deep, bright yellow colour, and a ſtrong, agreeable Honey-like ſmell, both which it loſes upon long keeping. In bleaching, the ſmell is deſtroyed along with the colour. It is not whitened, as ſome pretend, by Spirit of Wine: By the aſſiſtance of heat, it totally diſſolves in that menſtruum, and when recovered from it again proves darker coloured than at firſt. Water has no action on it. Diſtilled by a gradual fire, without addition, it almoſt totally ariſes in form of a butyraceous Oil, which grows ſtiff in the cold like Wax itſelf, and liquefies again on applying heat: Four ounces of Wax yielded four ounces of Oil, wanting only about a ſcruple; that which comes over firſt is whitiſh; that which follows, more of a browniſh hue. Boerhaave recommends this Oil as an extraordinary remedy againſt chaps in the breaſts. The principal uſe of Wax in medicine, is in cerates, plaſters, ointments, *&c.* It is uſed alſo internally as an ingredient in the *Balſamum Locatelli*, which is given in aſthmatic diſorders, and for healing ulcerations, but probably

on

on no juſt foundation, Wax is a tenacious ſubſtance not made for the human ſtomach to digeſt: The Turpentines and Balſams, whatever may be their good effects when externally applied, heat and ſtimulate when given inwardly, and thus ſeem more likely to aggravate the febrile ſymptoms that accompany conſumptive diſorders, than to heal the ulcerated lungs, which how great ſoever we ſuppoſe their healing power, they certainly cannot reach. The mechanic uſes of Wax are numerous, as for taking impreſſions, for anatomical injections, candles, Sealing-wax, for waxing thread, as a varniſh to cover Copper for etching with Aqua fortis, *&c. &c.* WAX.

GUM LAC, ſo called, has been ſuppoſed to exude in the Eaſt-Indies, from punctures made in the barks of trees by certain winged inſects. It appears to be truly a kind of Wax, collected by the inſect, and formed into regular cells like the honeycomb. It is found upon different kinds of trees, and not only upon living trees, but on ſticks which the Indians place in the ground for the inſect to work upon. There are indeed natural exudations, called Lacs from their uſe in lacquers and varniſhes; but theſe are entirely different from the Lac brought to us. IV. LACCA.

Gum lac is of a red colour, not of itſelf, but from the inſect. In many of the cells there are dead inſects, whoſe colour is gradually diffuſed by the ſun's heat, through the whole ſubſtance of the cell: Such maſſes as the inſects have not died in, or have not been expoſed to the action of the ſun, or have been gathered too ſoon, have little or no redneſs. The greateſt quantities are brought into England and Holland, from Malabar, Bengal, Pegu, Sumatra, *&c.* in maſſes adhering to the ſticks or branches of the tree, and hence called Stick lac, *Lacca in baculis, ramulis, ſurculis.* This is employed in ſundry places for dying ſcarlet (z), and for colouring leather: It is with this that the Turkey leather is ſtained. The Lac, beat off from the ſticks, is reduced into a groſs kind of powder, and a tincture extracted from it; after which the remaining Different forts, uſes, *&c.*

(z) *Dying ſcarlet.*] The ſcarlet dyed with Lac is leſs beautiful than that with Cochineal, but of greater ſolidity. Mr. Hellot obſerves that when employed in ſubſtance, the reſinous matter of the Lac is apt to melt in the hot liquor, and ſtain the cloth; and hence directs the colouring ſubſtance to be previouſly ſeparated in the form of lake.

For this purpoſe, half a dram of powdered Comfry root is to be boiled in a quart of water for a quarter of an hour; and ſome powdered Gum Lac digeſted in the decoction for two hours: The tincture appears of a fine crimſon colour, and the remaining Gum (if the quantity of liquor has been ſufficient to extract all its tinging matter) of a pale ſtraw colour. The tincture being poured off clear, and a ſolution of Alum gradually added to it, the colouring matter ſubſides, and the liquor remains colourleſs; The quantity of dried Fecula amounts to a little more than one fifth the weight of the Lac.

For dying, this Fecula is diſſolved in warm water, with the addition of a proper quantity of ſolution of Tin; and the fiery-red liquor poured into boiling water impregnated with Tartar, after the ſame manner as when Cochineal is uſed: The only difference is, that the Fecula of Gum lac diſſolves more difficultly than Cochineal, and hence is moſt conveniently diſſolved firſt by itſelf; and that it affords ſomewhat more colour. If, inſtead of Tartar and ſolution of Tin, any fixed alcaline Salt be uſed, the vivid red of the Gum lac changes into the colour of red-wine lees: Sal ammoniac changes it to a Cinnamon or Cheſnut colour.

LACCA. maining matter is dried, and ſold under the name of *Lacca in granis* or Seed-lac. The Stick-lac, melted over a gentle fire, and poured off from its impurities upon a Marble, forms dark-coloured cakes in appearance like Glaſs of Antimony, called *Lacca in tabulis* or Shell-lac. This laſt ſort is the deareſt of the three, and uſed chiefly in Sealing-wax. The Lac moſt common in the German ſhops is the Seed-lac, which generally has had a part of its colour extracted. This is in ſmall tranſparent pieces, like little Garnet ſtones. Its goodneſs is in proportion to its dark-browniſh red colour; but it is never equal to the Stick kind. Beſides being of a red colour in the maſs, it ought to tinge the ſpittle of a purple red.

Chemical examination. Gum lac may be looked upon as a very hard ſort of Wax, tinctured with an animal red of the Cochineal kind. The beſt Stick-lac, or the part which lies next to the wood, and which is moſt impregnated with inſects and with colour, yields in burning a degree of ſtench like that of animal matters. The Seed-lac does not diſſolve in water, nor in oils. I have digeſted it with a conſiderable heat both in expreſſed Oils, as that of Almonds, and in ſundry diſtilled ones, as thoſe of Aniſeeds, Turpentine and Thyme, without being able to obtain any other than a dilute tincture: The Oil of Thyme extracted moſt. I digeſted it alſo, with a heat raiſed to ebullition, in water acidulated with the Spirits of Vitriol, of Nitre, and of Sea-ſalt, and in diſtilled Vinegar; and with theſe alſo obtained only dilute tinctures: That with the nitrous acid was the paleſt. To Alum-water, it gave a beautiful tranſparent red. Alcaline Salts extracted more than the acidulated liquors, the tincture being thick, and of a quite dark violet-purpliſh red: The quantity diſſolved, however, was but ſmall. Of the concentrated mineral acids, the vitriolic extracted exceeding little, the marine ſomewhat more, and the nitrous nothing: This laſt not only acquired no colour itſelf, but deſtroyed that of the Lac, rendering it of a quite pale yellow. Spirit of Wine ſeems at firſt to have little action on Lac, extracting only a moderate tincture; but by perſeverance I have made it diſſolve at length nearly the whole: From ſixteen ounces of Lac I obtained fifteen of ſpirituous extract. The ſolution is not red but of a brown colour: It does not paſs through a filter, looks like a thick Mucilage, and does not eaſily part with the ſpirit. The ſame quantity of Lac, treated firſt with water, yielded one ounce and ſix drams of extract; after which, it gave out to rectified ſpirit fourteen ounces. Sixteen ounces of Seed-lac, diſtilled in an open fire, yielded nine ounces and ſix drams of a Butter or thick empyreumatic Oil, ſimilar to that of common Wax; after which aroſe one ounce and ſix drams of a watery liquor not manifeſtly acid or alcaline: The reſiduum weighed two ounces and a half.

Lac was formerly an ingredient in ſome officinal compoſitions; and in many diſpenſatories, a tincture of it in Alum-water is ſtill retained. It ſeems to be an article that medicine can very well ſpare, as it contains nothing of any remarkable activity. Its principal uſe is as a colouring drug, and for Sealing-wax: Thoſe who employ it in varniſhes, gain from it but little, if managed according to the common receipts.

SECT.

SECT. III.

Of PLANTS *or their* PARTS *in ſubſtance.*

CLASS I.

GUMMY VEGETABLES.

GUMMY VEGETABLES.

OF the plants whoſe prevailing principle is a gummy or mucilaginous ſubſtance, Marſhmallow and Comfry are the chief. We may obſerve in both theſe plants, what obtains but in few, that the roots, leaves, and ſeeds, agree in their chemical compoſition, and differ only in the quantity of Mucilage they afford, the roots yielding conſiderably more than any of the other parts. They contain alſo a reſinous matter; but the Gum is nevertheleſs their characteriſtic, as the Reſin has no particular taſte or ſmell, nor the plant any medicinal activity but what reſides in its Gum. As both plants are inodorous and inſipid, they give over nothing, or nothing conſiderable in diſtillation, either with water or with ſpirit.

I. MARSHMALLOW.

THE MARSHMALLOW is called *Althæa*, as ſome ſuppoſe from its healing quality (αλθαινω, *Sano*;) *Biſmalva*, *Malvaviſcus*, *Ibiſcus*, *Eviſcum*, from its viſcoſity, and from its having twice the power of the common Mallow. The ſpecies here intended is that which Caſpar Bauhine diſtinguiſhes by the name of *Althæa dioſcoridis & plinii:* It grows wild in watery places, though cultivated alſo in gardens. The root is pretty long, about the thickneſs of the finger, brown on the outſide, and white within.

Two ounces of the dry root yielded with water, ten drams fifty grains of mucilaginous extract; and afterwards with ſpirit forty-one grains of Reſin. The ſame quantity, treated firſt with ſpirit, gave ſix drams of a reſinous extract (*a*), a conſiderable portion of the Mucilage diſſolving in that menſtruum along with the Reſin: The remainder, boiled in water, gave out five drams and forty-eight grains of pure Mucilage.

From two ounces of the dry leaves were obtained, by water, five drams and two ſcruples of mucilaginous extract; and afterwards by ſpirit, three drams thirty-three grains of a reſinous one. From the ſame quantity, treated firſt with ſpirit, and then with water, were gained four drams two ſcruples of a reſinous

(*a*) *Six drams of reſinous extract.*] I have not obſerved the quantity of reſinous matter to be ſo large as in the author's experiment. From two ounces of Marſhmallow root, digeſted and boiled in freſh parcels of ſpirit, I obtained but two drams: The extract had more of a ſweetiſh taſte than that made with water; together with the light ſmell obſervable in the root itſelf.

MARSH-MALLOW. reſinous maſs, and afterwards three drams thirty-eight grains of Mucilage——The indiſſoluble earthy matter amounts in the roots to ſomewhat more than one fourth, and in the leaves to about one half of their weight.

II. COMFRY. COMFRY, from the extraordinary power of conſolidating wounds formerly aſcribed to it, has received the names of *Conſolida*, *Solidago*, and *Symphytum*. The officinal ſpecies is that which bears purple flowers, called Male Comfry, *Symphytum flore purpureo quæ mas*, *C. B:* It grows wild in moiſt fields and meadows. The root is about an inch thick, black on the outſide, and white within.

From two ounces of the dry root were obtained by water, twelve drams of gummy extract; and afterwards by ſpirit, eight grains of Reſin. It was pretty remarkable, that on digeſting the gummy extract in rectified ſpirit, near one half of it diſſolved; and that it was not made tenacious or coheſive by the ſpirituous liquor, but continued powdery. Two ounces of the root, treated with rectified ſpirit at firſt, gave four drams of reſinous extract, and afterwards with water, nine drams of Mucilage.

Theſe plants are employed medicinally as emollients and incraſſants, externally as well as internally; in plaſters, ſalves and ointments; in infuſions for chapt lips, and other like complaints; and by ſome of the French oculiſts for diſorders of the eyes. The Marſhmallow root, boiled with Red-ſaunders, or in red Wine, and afterwards dried, is uſed as a dentifrice, under the name of French Althæa.

III. FENUGREEK. THE ſeeds of FENUGREEK may be referred to this claſs, their prevailing principle being a mucilaginous matter: They are ſometimes uſed as an emollient in external applications, but chiefly againſt coughs and other like diſorders in cattle. The plant (*Fænum græcum ſativum*, *C. B.*) is in ſome places ſown in fields: It has a papilionaceous flower, and produces its ſeed in pods.

The ſeeds are of an oblong flattiſh quadrangular figure, rounded at one end, covered with a yellowiſh ſkin, which acquires a darker reddiſh or browniſh colour by age; internally of a very pale yellow; of a ſweetiſh but not agreeable ſmell; and an unpleaſant, bitteriſh, ſlimy taſte. They contain a portion of expreſſible Oil, intimately blended with the reſinous and mucilaginous principles; by the mediation of the firſt of which the Oil is extracted by Spirit of Wine, though it in great meaſure ſeparates afterwards during the evaporation of the tincture.

Sixteen ounces of the ſeeds yielded with water eleven drams and a ſcruple of a mucilaginous ſomewhat bitteriſh extract; and afterwards with ſpirit, half a dram of an unctuous Reſin. On applying ſpirit at firſt, I obtained from the ſame quantity, four drams and a half of a very ungrateful reſinous extract; after which, water took up ſix drams and a half of Mucilage. The diſtilled water ſmells a little of the Fenugreek, but gives no appearance of any eſſential Oil: It ſoon loſes the ſpecific flavour of the ſeeds, but continues ungrateful.

CLASS

CLASS II.

RESINOUS VEGETABLES.

RESINOUS VEGETABLES are thoſe, whoſe diſtinguiſhing taſte, medicinal activity, or colour, reſide in their Reſin; and which do not contain Gum or Mucilage enough, to render any conſiderable quantity of the Reſin ſoluble by infuſion or digeſtion in water. By ſtrong coction in water, great part of the Reſin may often indeed be melted out; but even in this caſe, it is far leſs perfectly extracted than by moderate digeſtion in rectified ſpirit. The ſubſtances of this claſs have little or no ſmell, and give over little or nothing, in diſtillation, with water or with ſpirit. RESINOUS VEGETABLES.

Gums or Mucilages are in all plants nearly the ſame; but Reſins differ extremely from one another. The inſipid and inactive Redſaunders; the aſtringent and bitter Peruvian Bark; the pungent Guaiacum and Pimpinella; the more acrid Pellitory and Staveſacre; the purgative Jalap, Turpeth, Mattaliſta, Hermodactyl; the emetic Ipecacoana and Aſarum; the more violent Bryony, Agaric, Colocynth, Hellebore; and the deleterious Coccognidia, Cocculus Indus, Nux vomica, and Faba ſancti Ignatii, owe their qualities to their reſinous principle.

RED-SAUNDERS is a hard, compact, ponderous wood, of a dark blackiſh-red on the outſide, and a light red colour within; of no particular ſmell or taſte. It is brought from the Coromandel coaſt, and from Golconda: Of the tree we have no certain account. Its principal uſe is as a colouring drug. Thoſe whoſe buſineſs it is to raſp and grind it into powder, probably employ certain ſaline or other additions to improve the colour; whence the remarkable differences in the colour of powdered Saunders prepared in different places: That of Straſburg is of the deepeſt and livelieſt red: Some ſorts are of a dead, dark red, and ſome of a pale brick red; ſome incline to purple or violet, and ſome to brown. RED-SAUNDERS.

The colour of this wood reſides wholly in its Reſin, and hence is extracted by rectified ſpirit, whilſt water, though it takes up a portion of mucilaginous matter gains no tinge, or only a ſlight yellowiſh one (*b*). From two ounces of the

(*b*) *Gives no red colour to water.*] This property readily diſtinguiſhes Red-ſaunders from Brazil-wood, which ſome have confounded with it; that wood communicating its red colour to water as well as to ſpirit.

ALKANET ROOT.

THE roots of Alkanet agree in the above reſpect with Saunders-wood, but differ from it remarkably in others. They impart an elegant deep red to pure Spirit of Wine, to Oils, to Wax, and to all unctuous ſubſtances: I do not know of any red drug that tinges Oil of ſo fine a colour. To water, they give only a dull browniſh. The ſpirituous tincture, on being inſpiſſated to the conſiſtence of an extract, inſtead of preſerving its fine red, like that of Saunders, changes to an unſightly brown. Volatile ſpirits have been ſaid to gain from this root a beautiful violet or amethyſt colour; but I have not found, that they extract any other than a dull reddiſh brown.

RED-SAUNDERS.

the wood were obtained by Spirit of Wine, three drams and a half of reſinous extract; and afterwards by water, a ſcruple of Mucilage. By applying water at firſt, I obtained from two ounces, two drams and ſix grains of a tough mucilaginous extract, which could not eaſily be reduced to dryneſs: The remainder ſtill yielded with ſpirit, two drams of Reſin. The indiſſoluble matter weighed in the firſt caſe, an ounce and a half and fifteen grains; in the latter, nineteen grains leſs. Neither the diſtilled water nor ſpirit had any remarkable taſte or ſmell.

The red colour of Saunders appears to be no other than a concentrated yellow, for by bare dilution it becomes yellow: A grain of the reſinous extract, diſſolved in an ounce of rectified ſpirit, tinges it red; but this ſolution mixed with a quart of freſh ſpirit, gives only a yellow hue. Hoffman reports that this Reſin does not give a tincture to any kind of Oil: I have tried five Oils, thoſe of Amber, Turpentine, Almonds, Aniſeeds and Lavender: It gave no colour to the two firſt, but a deep red to the laſt, and a paler red to the other two.

II. PERUVIAN-BARK.

PERUVIAN-BARK, *Cortex Peruvianus*, called, from its efficacy againſt intermitting fevers, *Febrifugum peruvianum*, *cortex antifebrilis* and *antiquartius*; and from a cure performed by it on the Lady of Count del Cinchon Viceroy of Peru, *Cortex China china or Chinchina*, *Kinkina*, *Quinquina*, *Comitiſſæ*, &c. was firſt brought into Europe, in the year 1649, by Cardinal de Lugo, who was then the Spaniſh Viceroy in the Weſt-Indies. It continued for ſome time a very lucrative ſecret in the hands of the Jeſuits, who reduced it into powder the better to diſguiſe it, and ſold it for its weight in Gold; whence its names *Pulvis jeſuiticus*, *Pulvis patrum*, *Pulvis Cardinalis de Lugo*.

The tree, called by Ray, *Arbor febrifuga Peruviana*, *China china*, *& quinquina*, *& gannaperide dicta*, is plentiful on the hills near the city Loxa in the province of Quito in Peru. It is ſaid, that the trees which grow at the bottom of the hills, have the thickeſt bark, ſmooth and whitiſh on the outſide, clear or yellowiſh-brown within, the leaſt bitter, and of the leaſt virtue; that the bark of thoſe

The Alkanet plant is a ſpecies of Bugloſs, named by Tournefort *Buglоſſum radice rubra*, *ſive anchuſa vulgatior floribus cæruleis*. It is a native of the warmer parts of Europe, and cultivated in ſome of our gardens: The greateſt quantities are raiſed in Germany and France, particularly about Montpelier, from whence we are chiefly ſupplied with the roots.

The Alkanet root produced in England is much inferior in colour to that brought from abroad; the former being only lightly reddiſh, the latter of a deep, purpliſh red. This has induced ſome to ſuſpect, that the foreign roots owe part of their colour to art; but a chemical examination teaches otherwiſe. The colouring matter is found, upon experiment, to be of the ſame kind in both, and to differ in ſeveral of its properties from that of all the other known red drugs; ſo that no artifice appears to be practicable without diſcovery, unleſs it was concentrating the colour of two roots into one, or ſuperſaturating one root with the colour extracted from another.

The principal uſe of Alkanet root is for colouring oils, unguents, lip ſalves, plaſters, &c. Wax tinged with it, applied on warm Marble, ſtains it of a fleſh colour, which ſinks deep into the ſtone: The ſpirituous tincture gives a deep red ſtain.

The colour of this root is confined to the cortical part, the pith being whitiſh: Hence, as the ſmall roots have more bark, in proportion to their bulk, than the large ones, thoſe alſo contain moſt colour.

thoſe on the top is ſomewhat bitterer, thin, full of protuberancies, of a blackiſh colour on the outſide, and of a dark brown within: That thoſe produced about the middle height yield the bittereſt and beſt bark, not ſo ſmooth and pale coloured as the one, nor ſo rugged and dark coloured as the other. Vaillant, a celebrated botaniſt of Paris, aſſured me that he knew ſix ſorts; and confirmed the account given by Lemery and Pomet, that Potoſi affords the beſt; that this is much browner, bitterer, more aromatic and more pungent, than the Bark of Quito. But our buſineſs is to chuſe the beſt of what is brought to us. This is externally of a blackiſh brown, and internally of a dark cinnamon colour, ſomewhat unequal on the ſurface, compact, firm, and not eaſy to break, of a moderately bitter aſtringent taſte, with a mixed kind of aromatic and muſty flavour. The large thick pieces are ſeldom good: Thoſe which are rolled up into quills like Cinnamon, are apt to have foreign matters lodged within, and therefore ſhould be broke and examined before we pulverize them for uſe. PERUVIAN BARK.

Mr. Boulduc obtained, from a pound of Bark, only five drams and a ſcruple of ſpirituous extract: In my experiments, a pound yielded, with rectified ſpirit, ten drams and two ſcruples of reſinous, and afterwards with Water, five drams of gummy extract: On applying Water at firſt, I obtained ſeven drams and a ſcruple of gummy, and afterwards by ſpirit, ſix drams of reſinous extract. Theſe experiments ſhew a remarkable difference betwixt Peruvian-bark and Caſcarilla, which is ſuppoſed to be of the ſame kind: From a pound of Peruvian-bark we obtain at moſt but two ounces and five ſcruples of extract, reckoning the gummy and reſinous together (*x*); whilſt a pound of Caſcarilla yields upwards of ſeven ounces and a half: The latter contains alſo an eſſential Oil, of which we diſcover nothing in the former. The extract made from Bark by applying Water at firſt, taſtes conſiderably bitter and aſtringent, but not near ſo much ſo as that made by ſpirit—The principal uſe of this Bark is in the diſorder againſt which it was at firſt introduced, intermitting-fevers: It is given to half a dram and upwards, every fourth hour during the intermiſſion, in conjunction with Sal ammoniac or vitriolated Tartar, which prevent its occaſioning the ill conſequences that it is apt to do by itſelf.

GUAIA-

(*x*) *Quantity of extract.*] Different ſorts of Peruvian-bark differ conſiderably in their yield of extract. Thoſe which I examined afforded a much larger quantity of reſinous extract than the author obtained from his.

It is obſervable of this drug, that its aſtringency reſides wholly in its Reſin, which does not appear to be in any degree ſoluble in watery liquors; but its bitterneſs in a gummy-reſinous ſubſtance, or ſuch an one as is diſſoluble both in Water and in Spirit. Both principles may be extracted by boiling in Water; the Reſin melting out by the heat, and rendering the liquor turbid: The decoction, in this ſtate, taſtes aſtringent as well as bitter, but on ſtanding it depoſites the Reſin and becomes clear, and then proves ſimply bitter. Repeated coction and large quantities of Water are neceſſary for extracting all the virtues of the Bark: The Reſin melts out in the firſt boilings; the decoctions made afterwards are tranſparent and bitter, without the leaſt turbidneſs or aſtringency.

III. GUAIACUM, *Lignum guaiacum, guaiacan, benedictum, ſanctum, vitæ, Palus ſanctus, Palma ſancta*, is the wood of two kinds of trees growing in America, called by Plukenet, the one *Guaiacum Jamaicenſe, &c.* the Jamaica Guaiacum-tree, with bright green roundiſh leaves like thoſe of the Maple; the other *Euonymo adfinis occidentalis, &c.* an occidental nut-bearing tree, allied to the Euonymus or Spindle-tree, with winged leaves like thoſe of butcher's broom, and a fungous bark at the joints. The wood comes over in large pieces, weighing four, five and more hundred weight, from Jamaica, Mexico, Porto-rico, Borigue, St. Domingo, and other parts of the Weſt Indies: The tree has been raiſed alſo in Europe, but proved far inferior in quality to that produced in its native climate, and yielded nothing of the reſinous juice which it plentifully bleeds there. (See page 298.)

GUAIACUM

Wood. This wood is remarkably hard, compact, and ſo heavy as to ſink in Water; of a brown, or yellowiſh brown colour, often blackiſh, or marbled as it were with different colours: When the tree is ſtanding or newly felled, the bark adheres ſo firmly as not to be got off even with iron tools; after lying for ſome time it ſeparates eaſily. On account of its great hardneſs, ſolidity, and indiſpoſition to crack, it is employed by the turners and others for ſeveral of the more curious mechanic uſes.——In Holland, at Hamburg and other places of large commerce, it is raſped in workhouſes eſtabliſhed for that purpoſe, after the ſame manner as the Colouring-woods; and from theſe the druggiſt and apothecary are ſupplied.

Guaiacum is a very reſinous Wood: On expoſing it to a moderate heat, the Reſin viſibly melts out. By digeſtion in highly rectified Spirit of Wine, I obtained three ounces and a half of reſinous extract from ſixteen ounces of the Wood: Such as had been boiled in Water till that menſtruum would take up no more, yielded ſtill, with rectified Spirit, two ounces of Reſin upon the pound. Water applied at firſt extracts an ounce and a half, and after ſpirit has performed its office half an ounce and two ſcruples, of gummy matter. The indiſſoluble part, when the gum was extracted firſt, weighed twelve ounces and a half; when the Reſin was firſt extracted, only twelve ounces and two drams. Theſe experiments were made with chips of a good reſinous kind of Guaiacum: The raſped Wood commonly ſold yields leſs of a reſinous and more of a gummy extract. From a pound of good raſpings I obtained by Spirit two ounces and ſix drams, and afterwards by Water one ounce: Another pound of the ſame, treated with Water at firſt, gave two ounces, and afterwards with Spirit one ounce and ſix drams.

A ſtrong decoction of Guaiacum is uſed as an alterative diet-drink in venereal, cancerous, and other diſorders from an impurity of the blood and juices. Hoffman recommends the ſpirituous extract (which is the moſt active preparation) as a high antidote againſt the venereal poiſon, provided it be uſed properly according to the laws of medicine. He mentions alſo another reſinous preparation of this Wood, under the title of "A ſingular Reſin, of a ſtimulating errhine quality, and poſſeſſing alſo a corroborating power, highly friendly to the nervous parts of the head:" This, according to his account,

count, is the Reſin that precipitates in boiling down a watery decoction of the Wood. GUAIACUM

A pound of Guaiacum Wood, diſtilled in an open fire, gave three ounces and a half of Spirit, and one and a half of empyreumatic Oil. Some report, that the ſpirit is of the neutral kind; that it makes no effervescence either with alcalies or with acids, and that it forms an ink with Vitriol: I have obſerved, that it does effervesce conſtantly with alcalies, though not very ſtrongly, on account of its oily matter which ſheathes the acidity; and that with Vitriol it ſtrikes a blackiſh brown colour, but by no means an inky blackneſs. I have not found that a decoction of the Wood changes Syrup of Violets red, as ſome relate that it does; nor that the Wood in the maſs, in chips, or in raſpings, heated by itſelf or with Oil, would take fire on the affuſion of Oil of Vitriol, or of a mixture of Oil of Vitriol with Nitre or its concentrated Spirit.

OF the Bark of Guaiacum, there are two kinds, one ſmooth, the other unequal on the ſurface: The former is ſaid to be the Bark of the firſt of the trees above-mentioned, the other of the ſecond. Some confine the name *Guaiacum* to the Wood and Bark of the firſt ſort, and that of *Sanctum* to the latter; but there is no remarkable difference betwixt the two. Greateſt part of the Bark that comes to us is moderately ſmooth; externally of a dark grey colour, with blackiſh yellow and greeniſh ſpecks, internally yellowiſh, reddiſh or browniſh; compoſed of plates or a number of thinner rinds applied ſucceſſively upon one another; compact and heavy; of a bitteriſh diſagreeable taſte. Bark.

Eight ounces yielded one ounce and four ſcruples of reſinous extract, and afterwards five drams and one ſcruple of a gummy one. The ſame quantity, treated firſt with Water and then with Spirit, gave ten drams one ſcruple of gummy, and four drams of reſinous extract. The indiſſoluble part weighed, in both caſes, ſix ounces and two drams.

PIMPINELLA, or *Bipennula*, ſuppoſed to be ſo called from its leaves ſtanding in double rows like feathers, is an umbelliferous plant, growing wild in dry, ſandy, gravelly grounds. The ſpecies directed for medicinal uſe is the *Pimpinella Saxifraga major umbella candida. C. B.* or greater Burnet Saxifrage with white flowers; but we may take promiſcuouſly the roots of the ſmaller ſorts, provided they are not produced in moiſt rich ſoils: One and the ſame ſpecies differs more in different ſoils, than different ſpecies do in one ſoil. The roots are of a pale yellowiſh colour, about the thickneſs of the little finger at moſt, of a peculiar ſmell, and an acrid burning taſte. IV. BURNET SAXIFRAGE

This root contains a portion of eſſential Oil: On diſtilling a large quantity with Water, the diſtilled liquor is not only impregnated with its flavour, but ſome particles of actual Oil may be diſtinguiſhed; much too inconſiderable however to entitle the plant to a place among the oily ones. The pungency and diſtinguiſhing taſte of the Pimpinella reſide wholly in its Reſin: What Water extracts, diſcovers only a ſweetiſh taſte, with no remarkable pungency.

Two

PIMPINEL. Two ounces of the root, cut in pieces, yielded, with Water, ſix drams and a ſcruple of gummy extract; and afterwards, with Spirit, only two ſcruples of a reſinous one; this laſt was in taſte extremely nauſeous. Two ounces more, treated firſt with Spirit, gave four drams of reſinous extract; and afterwards with Water two drams two ſcruples of an inſipid and inodorous gum. It is obſervable, that the ſpirituous extract is in taſte far more diſagreeable than the tincture, and impreſſes a particular diſguſtful oilyneſs. In effect this root contains a groſs oily matter, of the expreſſible kind; which rectified ſpirit extracts along with the Reſin, and which in the tincture is diluted and concealed by the ſpirit, but ſeparates and diſcovers itſelf on drawing off the menſtruum. A ſaturated tincture or eſſence is therefore the beſt preparation of Pimpinella.

This root is a powerful reſolvent and aperient medicine: It promotes perſpiration and urine, purifies the blood and juices, and proves remarkably ſerviceable in diſorders of the fauces, catarrhs, infarctions of the breaſt by viſcid phlegm, obſtructions of the viſcera, and the conſequences of ill managed mercurial ſalivations. A mixture of the eſſence with Syrup of Violets, or a tea-ſpoonful of the eſſence by itſelf, is a common medicine, in Germany, for ſore throats.

V. PELLITORY. PELLITORY, called from the fiery taſte of its root *Pyrethrum*, is a plant with Fennel like leaves, and a flower like that of the common purpliſh daiſy: Hence it is named by Caſpar Bauhine *Pyrethrum flore bellidis*. It is generally ſaid to be an oriental plant: Pomet relates that it grows plentifully about Tunis, and that the Pellitory uſed in France is imported from thence by the way of Marſeilles. Some report that it is found on the hills of Switzerland and Italy; but of this I find no account in the Italian botaniſts: Nor indeed is the plant deſcribed by any of the modern botaniſts I know of. Thus much is certain, that it does not grow in the dutchy of Magdeburg, as Schurtzius and others affirm. We find there a ſpecies of *Pharmica* whoſe roots are called by ſome Pellitory, and uſed like it as a Maſticatory; but none of the true Pyrethrum.

Pellitory roots are ſold in bundles, tied up with ſtrong twigs: They are ſeldom ſo thick as the little finger, and have generally a piece of the woody ſtalk at the head: The beſt are dry, compact, of a brown colour, not eaſy to cut with a knife. The characteriſtic property of this root is its hot burning taſte, which reſides not in a ſaline matter, as Lemery, Juncker and others affirm, but wholly in a reſinous one; water extracting a little of it, but rectified ſpirit the whole. It is obſervable, that notwithſtanding the extreme acrimony of this root, the quantity of matter on which that quality depends, is very ſmall, ſcarcely amounting to a ſcruple in an ounce.

Two ounces of the root, treated with rectified ſpirit, gave no more than two ſcruples of extract, in which, as in other extracts made by ſpirit at firſt, a portion of gummy matter was retained along with the Reſin; the reſiduum digeſted with water, gave nine drams and a half of gummy extract, ſix drams, all but twelve grains remaining undiſſolved. On inverting the procedure, and applying water at firſt, I obtained from the ſame quantity of Pellitory, ten drams of gummy

gummy extract, and afterwards by ſpirit only one ſcruple of Reſin, the undiſ- PELLITORY.
ſolved part weighing five drams thirty-ſeven grains.

Both the ſpirituous extracts were exceſſively fiery; that made after water did not diſcover its fieryneſs in the mouth ſo ſoon as the other, as being more purely reſinous, and conſequently more difficultly acted upon by the Saliva, on account of the previous ſeparation of the gummy parts by the water. The watery extracts could ſcarce be reduced into an uniform coherent maſs, being diſpoſed rather to a crumbly or powdery conſiſtence. Water diſtilled over from the root, elevated a little of its acrid matter, perceptible upon keeping the liquor for ſome time in the mouth.

The principal uſe of this root is as a maſticatory in paralytic and lethargic diſorders, particularly in palſies of the tongue, and in toothachs, either by itſelf, or made into troches with other ſubſtances, and as an ingredient in ſtimulating cataplaſms. It is ſometimes likewiſe given internally, for heating, ſtimulating, ſtrengthening the ſtomach, and diſſolving viſcid phlegm. The Vinegar-makers employ it for making their Vinegar ſharper.

VI. STAVESACRE.

STAVESACRE, *Staphiſagria*, is referred by ſome botaniſts, from its flowers, to the genus of Larkſpurs; by others, from its ſeeds, to that of Aconites. Tournefort calls it "Larkſpur with leaves like thoſe of the Plane-tree;" and Plukenet "the burning Aconite, with leaves almoſt like thoſe of Ricinus, "and a large blue flower." It is a native of the ſouthern parts of France, of Italy and Spain, particularly Apulia and Calabria; but the greateſt quantities are met with in Dalmatia and Iſtria: It loves ſhady places.

The part made uſe of is the ſeeds, of which four, five, or ſix are commonly joined together in one cod, ſo as to appear one roundiſh kernel. The ſingle ſeeds are of an oblong, irregularly triangular figure: Two of the ſides, by which each ſeed had been joined to two others, are flat; the third, contiguous to the cod, is rounded. They are covered on all ſides with a rough rugged membrane, which when perfectly ripe is of a brown colour: Under this lies another thin ſkin, which incloſes a white kernel, of a diſagreeable, bitteriſh, hot taſte: By age, the kernel becomes yellow and browniſh.

Theſe ſeeds are employed chiefly in ointments for deſtroying cutaneous inſects, whence their name *Grana pedicularia*; and as a maſticatory for toothachs, *&c.* Taken internally, they operate with violence both upwards and downwards: The ancients ventured on their internal uſe, and I have myſelf ſeen them given in Poland; but the practice is by no means to be followed. Even when applied externally, they have been productive of dangerous conſequences, of no leſs than the epilepſy. Simon Paulli and others obſerve that they have a ſtrangulatory quality: And profeſſor Schulze relates, that his ſenſes were diſordered by chewing ſome of them for a toothach. Thus much is obvious to the taſte, that they have a nauſeous burning heat and acrimony, which reſides rather in the kernel than in the ſhell.

An ounce of the ſeeds reduced into powder, yielded with rectified ſpirit two ſcruples and five grains of reſinous extract: In this proceſs, a groſs Oil of the expreſſible kind, ſeparated, to the quantity of a dram and a half: The matter left by ſpirit, digeſted and boiled with water, gave two ſcruples four grains of

STAVESACRE. gummy extract, near five drams remaining at last undissolved. Another ounce, treated first with water, yielded one dram and thirty-five grains of gummy extract; and afterwards with spirit, one dram and eleven grains of gross Oil, but no more than a single grain of Resin: The indissoluble residuum weighed five drams nine grains." As the watery extract retains great part of the Resin, it proves considerably acrid, though far less so than the spirituous: The extract made by water after spirit has performed its office, discovers no acrimony. In distillation, spirit brings over nothing; the distilled water tastes somewhat disagreeably.

VII. GRANA CNIDIA. COCCOGNIDIUM or *Granum cnidium* is the berry of a shrub, growing wild in Germany in moist shady woods, called by an Arabic name *Mezereon*, and from its leaves bearing some resemblance to those of the Bay and of the Olive-trees, *Laureola* and *Chamelæa*. The species which produces the Coccognidia is named by Caspar Bauhine *Laureola folio deciduo, flore purpureo, officinis Laureola femina.* The flowers come forth early in the spring before the leaves; they are small, monopetalous, shaped somewhat like a funnel, of a pale purplish-red colour, and an agreeable smell, whilst all the other parts of the plant are disagreeable. The leaves, which follow the flowers, are soft, of a pale green colour, without any glossiness. The stalks and branches are very flexible, covered with two barks; the outermost of which is of an ash-colour, thin, and easily peeled off; the innermost green on the outside, white within, very tough, and hard to tear——The berries are at first green, afterwards red, and when ripe of a brown colour: They are much about the size, and partly of the appearance of Pepper-corns: They contain under the outward brown skin, another thin smooth one, commonly greenish and glossy; and under this a third, which looks as if coated with black varnish: Under this lies the kernel, of a white colour, and about the size of a grain of Hemp-seed.

The leaves and the bark were formerly used as purgatives, but have long been justly laid aside on account of the violence of their operation: The correction of them by maceration in Vinegar or Milk is insignificant. The berries are in a high degree virulent: The kernels, applied externally, inflame and exulcerate the skin; chewed, they discover little taste at first, but in a short time begin to burn the mouth like a coal; swallowed, they occasion immense vomitings and purgings, inflammations of the bowels, and even death. As experience has fully evinced their deleterious qualities, it is surprizing that any medical writer should recommend them; and yet we find both the berries in substance, and a watery extract made from them, directed as an evacuant in dropsies: Though the extract is more active than the berry itself, Herman recommends half a dram of it for a mild medicine.

With regard to the chemical composition of this fruit, it contains, besides its caustic Resin, and a gummy matter, a considerable portion of an expressible Oil. The Oil is of itself mild and insipid as the other Oils of that class; but as these kinds of Oils are menstrua for Resins, it retains, in most of the processes by which it is separated, so much of the Resin, or of its more subtile parts, as to prove highly acrimonious: Half a grain of the resinous extract gives a fiery taste to half an ounce of insipid Oil. From four ounces of the berries I obtained by expression

expreſſion half an ounce of Oil, conſiderably acrid. An ounce of the berries, boiled with water, gave five ſcruples ſeventeen grains of extract; and five ſcruples and a half of a milder Oil, which ſeparated in the operation: The remainder, treated with ſpirit, gave two ſcruples of Reſin. Another ounce digeſted at firſt with ſpirit, yielded four ſcruples and eight grains of a reſinous maſs, after which water extracted two ſcruples thirteen grains of inſipid Mucilage. GRANA CNIDIA.

It is obſervable, that though groſs Oils are not of themſelves ſoluble in Spirit of Wine, yet the Oil is here ſo intimately combined with the other principles, as to be extracted by the ſpirit, and remain uniformly mixed till great part of the menſtruum is evaporated; the groſſer Reſin then ſeparates and falls to the bottom, and the fluid Oil, ſtrongly impregnated with the more ſubtile cauſtic matter of the Reſin, floats on the ſurface.

VIII. COCCULUS INDUS.

COCCULUS INDUS is the berry of an oriental plant, ſuppoſed to be a ſpecies of *Solanum*, and called by Ray *Solanum racemoſum Indicum*, &c. or Indian-tree Nightſhade producing its fruit in cluſters like grapes. The berries are brought to us from Alexandria and other parts of the Levant. They are partly about the ſize of Bay-berries, and partly of that of Chich-peas; roundiſh, but hollowed in a little towards the ſtalk, and approaching to a kidney ſhape, rough on the outſide, and of a grey-browniſh or blackiſh colour: The freſher they are, the heavier; the older, the dryer and lighter.

In their ſtructure, they greatly reſemble the Coccognidia, conſiſting of two ſhells and a kernel, in which laſt their activity reſides: The outer ſhell is thin, the inner thicker and whitiſh; the kernel is more manifeſtly of a kidney ſhape than the entire berry, when freſh of a white colour, but very apt to grow yellow and brown: It ſoon likewiſe becomes rancid, and is preyed on by worms, inſomuch that moſt of the berries, as we commonly meet with them, are found to be mere ſhells without any kernel.

The Cocculus indus agrees alſo with Coccognidium in its deleterious purgative and emetic quality, though it does not diſcover ſuch a burning heat in the mouth, and impreſſes only a kind of bitterneſs. In Wepfer's treatiſe on the *Cicuta aquatica*, there are ſeveral obſervations of the effects of this berry on cats and dogs: Some died in a ſhort time, vehemently convulſed: Others, after ſuffering violent torments recovered——Some recommend it to be held in the mouth for abating toothachs, or a mixture of it with one third its weight of Sal ammoniac to be put into the hollow tooth; but even this uſe of it is ſcarcely ſafe. It is principally employed in ointments for deſtroying cutaneous inſects, and in fiſhing. For this laſt purpoſe, a mixture of the powdered Cocculus with Rye-meal, old Cheeſe, Spirit of Wine and other ſubſtances, is formed into ſmall pellets or pills, which are uſed as a bait, or only thrown by themſelves into waters ſtocked with fiſh: The fiſhes by ſwallowing the pills, are ſtupefied and benumbed, ariſe to the ſurface, and may be eaſily caught by the hands.

The Cocculus indus contains a groſs Oil like the Coccognidium, but in leſs quantity; the Oil does not ſeparate on treating the berry with water or ſpirit, but remains united with the extracts, and renders the ſpirituous in particular

COCCULUS INDUS. quite unctuous. An ounce of Cocculus gave one dram of ſpirituous, and afterwards three drams of watery extract; four drams remaining undiſſolved. On inverting the order of applying the menſtrua, the quantity of the reſpective products was exactly the ſame, water extracting at firſt three drams, and ſpirit, afterwards, one. The watery extract taſted ſtronger than the ſpirituous.

IX. NUX VOMICA. NUX VOMICA, ſo called, is not a nut, but the ſeed of a fruit like an Orange, growing in the Eaſt-Indies: It is called by the Germans *Kræhen-augen*, Crows-eyes, from its having ſomewhat of the appearance of a grey eye, and from its being poiſonous to crows. The tree is deſcribed and figured in the *Hortus Malabaricus* under the name of *Caniram*. The ſeeds brought to us are of different ſizes, and produced by different ſpecies of the plant: The tree which yields the ſmaller ſort is that whoſe roots are the *Lignum colubrinum* of the ſhops. They are commonly of a roundiſh flat figure variouſly bent, with a navel or prominence in the middle, covered all over with fine ſhort hairs like velvet: The kernel is nearly of the conſiſtence of horn, but harder and more brittle, ſo as to be beat in pieces by a hammer.

An ounce of Nux vomica, raſped into fine powder, yielded with water half an ounce of gummy extract, and afterwards with ſpirit only five grains of Reſin; another ounce, treated firſt with ſpirit, gave one dram thirty-two grains of reſinous extract, and afterwards two drams thirty-ſix grains of Mucilage; the indiſſoluble part amounting to about half the weight of the ſeed. Both the watery and ſpirituous extracts, prepared at firſt, are very bitter, particularly the ſpirituous: Thoſe made by either menſtruum, after the other has performed its office, have little bitterneſs. In diſtillation, neither water nor ſpirit bring over any thing remarkable. The watery ſpirit of Sal ammoniac digeſted on this ſeed, gains a deeper colour than any other menſtruum; the tincture is browniſh-red. The vinous Spirit of Sal ammoniac ſcarce extracts a yellowiſh hue; and ſimple Spirit of Wine receives no tinge at all.

Nux vomica is poiſonous to dogs, to other carnivorous animals, and ſuch as are born blind. It does not indeed follow from hence that it is poiſonous to men; and ſome have even recommended it as a notable diaphoretic and alexipharmac; and Melichius obſerves that it is eaten by the Turks without injury. But Seutter tells us of a woman in Holland, who on taking a doſe of Nux vomica, mixed with a little Gentian, for the cure of an intermitting fever, was thrown into violent convulſions, from which ſhe difficultly eſcaped with her life: This one example is ſufficient to deter us from the uſe of the Nux vomica, eſpecially as we are furniſhed with efficacious and unſuſpected medicines for all the intentions in which it is recommended. It is obſervable, that the outer ſkin, and its hairy covering, are more virulent than the kernel.

X. ST. IGNATIUS'S BEAN. ST. IGNATIUS'S BEAN, *Faba ſancti Ignatii*, *Faba febrifuga Bironiæ*, *Igaſur*, &c. is not a bean, but the ſeed of a fruit of the gourd kind. The beſt account of the plant that has yet appeared, is that ſent by Father Camelli to Ray and Petiver, and publiſhed in the Philoſophical Tranſactions for the year 1699: He obſerves, that it grows in the Philippine iſlands, and winds itſelf about the talleſt trees to the top; that it has large, ribbed, bitter leaves, a flower like that

that of the Pomegranate, and a fruit larger than a Melon. Some reſemble the fruit to a Pomegranate, probably from miſapplying Camelli's words. The fruit is covered with a thin, gloſſy, blackiſh-green, and as it were marbled ſhell, under which is lodged another of a ſtony hardneſs: Within this is contained a ſoft, yellow, bitteriſh pulp, in which lie the ſeeds or beans to the number commonly of twenty-four, each covered with a ſilvery down. IGNATIUS'S BEAN.

The ſame gentleman gives an account of the virtues attributed to theſe ſeeds by the Indians; but experience has ſhewn that they are dangerous. Konig relates that a perſon, by drinking ſome of a ſpirituous tincture of them inſtead of Aqua vitæ, was thrown into ſtrong convulſions; and Dr. Grim, that a dram of the ſeed in ſubſtance occaſioned, for a time, a total deprivation of the ſenſes. Others mention violent vomitings and purgings from its uſe. The only good effect I have myſelf obſerved from this ſeed is the removal of intermitting fevers by drinking, on the approach of a paroxyſm, an infuſion of ſome grains of the Bean made in Carduus water: We are not however from hence to look upon this medicine as an univerſal Febrifuge, or to uſe it indiſcriminately.

Theſe Beans (for ſo cuſtom requires that we ſhould call them) are about the ſize of a moderately large Nutmeg; in figure ſomewhat roundiſh, but extremely irregular, ſcarcely any two being entirely alike, full of unequal depreſſions and prominencies; in colour, externally yellowiſh-brown, but when the outer ſkin is taken off, of a blackiſh-brown, and in part quite blackiſh; in conſiſtence hard and compact as horn, ſo as not to be reducible into a powdery form but by cutting or raſping: For all their hardneſs, however, they are not proof againſt worms. When freſh, they have ſomewhat of a muſky ſmell, which by age is loſt: Their taſte is very bitter, reſembled by ſome to that of Centaury.

Four drams of theſe Beans, boiled in water, gave juſt two drams of gummy extract; after which, rectified Spirit of Wine ſcarcely took up half a grain. Half an ounce, treated firſt with ſpirit, gave two ſcruples and a half of reſinous extract, and afterwards with water three ſcruples and a half of a gummy one. The ſpirituous extract made at firſt is of a yellowiſh colour, and the watery greeniſh. They are both bitter: The ſpirituous impreſſes at firſt a very agreeable bitterneſs, ſomewhat like that of Peach-kernels; which going off, leaves in the mouth a ſtrong bitter. The diſtilled liquors have no taſte or ſmell.

XI. WHITE HELLEBORE.

THE name HELLEBORE, ſuppoſed to be derived from ἑλεῖν βορᾶ to kill by eating, is applied to different roſaceous-flowered plants. The white Hellebore is made by Tournefort a diſtinct genus from the black, under the name of *Veratrum*; its ſeed veſſels wanting the horns which thoſe of the other have, and its ſeeds being ſurrounded with a leafy margin, which thoſe of the other are not: He calls the officinal ſpecies *Veratrum flore ſubviridi*, greeniſh-flowered *Veratrum*, in diſtinction from another, whoſe flowers are of a blackiſh red colour.

This plant grows wild in France, Switzerland, Auſtria and other countries, but is not a native of Germany. The root, which is the only part made uſe of, is oblong, an inch thick or more, of a blackiſh grey colour on the out-

WHITE HELLEBORE.

side and white within, surrounded with small fibres, crooked and unequal, of a nauseous, acrid, bitterish, astringent taste, and no smell.

Two ounces of white Hellebore-root yielded with Water nine drams and a scruple of gummy extract; and afterwards, with Spirit, only half a scruple of Resin. The same quantity, treated first with Spirit, yielded seven drams of resinous, and afterwards with Water near three drams of gummy extract. Neither Water nor Spirit elevate any thing remarkable in distillation.

White Hellebore-root is a violent emetic: Matthiolus reports, that the Spaniards prepare an actual poison from it. The resinous preparations are particularly unsafe. A tincture made with Spirit of Wine from two ounces of Bryony-roots, two ounces of Sowbread-roots, and one ounce of white Hellebore-roots, was formerly in some esteem as an emetic, under the title of *Vomitorium conradinum:* So great is the activity of this liquor, that the little which a feather takes up, not exceeding perhaps two drops, received in Wine, is a sufficient dose. This root has been supposed peculiarly serviceable in maniacal disorders: Its violence however is so great, that it is most prudently refrained from: There are several instances in the *Ephemerides naturæ curiosorum* and other books, of its having proved fatal.

Its principal use is as a purge and vomit for cattle; in ointments against some kinds of cutaneous eruptions, and insects; and as a sternutatory. A red Sternutatory powder may be made by moistening, with a tincture of the Hellebore-root, powdered clovy July-flowers, which may be ground with a little Almonds to improve the colour; a green one with powdered Betony leaves, and a white with Creme of Tartar or Sugar.

XII. BLACK HELLEBORE.

THE roots of BLACK HELLEBORE consist of a number of slender black or browniſh-black fibres hanging from one head; the fibres, which are the part made use of, have nothing of the woody pith, which some direct us to search for and throw away. The narrower-leaved Black-hellebore with Rose-coloured flowers is the species whose roots are generally understood as the officinal kind; those of the larger-leaved sort are little different; those of the garden green-flowered Black-hellebore are inferior in quality to both the others, though among us (in Germany) most commonly made use of. All the three grow wild in several of the mountainous parts of Europe, as in Tyrol, Switzerland, Austria, England, *&c.*

The roots of Aconite or Napellus greatly resemble those of Black-hellebore, and have sometimes been mistaken for them: Of the unhappy consequences arising from this mistake, there is an account in the Breslau collections for the year 1720. As the Aconite-roots incline more to a brown than a blackish colour, we should be careful in purchasing Hellebore, to chuse the blackest: In this light, the first of the Hellebores above-mentioned is to be preferred, as its roots are blackest, and consequently the most distinguishable from the poisonous root.

Black-hellebore root has a nauseous sweetish taste; which is followed by a bitter one that dwells long upon the tongue: It has no smell. No one has given any satisfactory chemical analysis of it, but Monsr. Boulduc: The experiments, however, which that gentleman gave in to the French Academy, were

were not made by himſelf, but by a German chemiſt, Dr. Groſſe. In my experiments, ſix ounces of the root, treated firſt with rectified ſpirit, gave ſix drams and a ſcruple of extract; after which, water extracted three drams one grain and a half: Water applied at firſt took up ſix drams two grains, and rectified ſpirit afterwards three drams one grain. Thus which ſoever menſtruum we apply at firſt, it extracts about ſix ſixteenths, leaving three ſixteenths which may be extracted by the other; about ſeven ſixteenths remaining unaffected by either. BLACK HELLEBORE.

The ſpirituous extract, whether made from the root directly, or from ſuch as has undergone the action of water, appears of a ſoft unctuous conſiſtence, this root containing a portion of groſs Oil, of the expreſſible kind; a principle which eſcaped Boulduc's examination. The ſpirituous extract made at firſt, being digeſted in water, about three fourths of it were diſſolved, and the remaining fourth proved a quite thin oily-reſinous matter. Some report that the diſtilled water has a manifeſtly ſharp taſte. Borrichius relates, in his apology againſt Conringius, that a water diſtilled from Black-hellebore in the heat of a water-bath, given to a boy to the quantity of eight ſpoonfuls, occaſioned gripes and motions to ſtool; and that a dog, by twelve ſpoonfuls, was four times vomited, and twice purged. This experiment deſerves to be farther examined: The diſtillation ſeems to have been made from the entire plant.

The root in ſubſtance is a ſtrong ſtimulating cathartic, and in ſmaller doſes, a powerful aperient: Hence it is recommended in maniacal, and melancholic and hypochondriacal diſorders, in quartan agues, in menſtrual and other obſtructions. The beſt preparation is a watery extract made by long boiling, which may be given from three to ſix grains made into pills with other ingredients: The ſpirituous extract is too violent.

XIII. AGARIC.

AGARIC is a ſpongy fungous ſubſtance growing on the trunk of a tree, or in the language of the ancients, an excreſcence or apoſtem from age or diſeaſe. The tree is the common Larch, from which Turpentine is obtained. (See page 287.) It grows wild in Dauphiny, Savoy, on the Alps, in Auſtria, Tartary, *&c.* and is the only coniferous tree that ſheds its leaves in the winter: When it grows old, the fungus comes forth in ſeveral places on its trunk, and if the tree is large, on the firſt branches.

The fungus is of various ſizes, ſometimes not exceeding the bigneſs of the fiſt, ſometimes as large as a man's head: It takes at leaſt a year to grow to its full ſize. There are two kinds of it, called by the ancients *Mas* and *Femina*. The male Agaric is dark-coloured, hard, heavy and woody: It is ſeldom taken from the Larch, but chiefly from old Oak-trees, and hence is called by ſome Agaric of the Oak: It is quite unfit for any medicinal uſe, and is only now and then employed by the dyers as an ingredient in the black dye. The female or officinal Agaric is covered with a hard blackiſh rind like the other; but when the cortical part is pared off, the internal ſubſtance appears quite white: By age, it changes a little yellowiſh. It ſhould be very light, porous, eaſy to break, free from any hard pieces or compact veins. Taſted, it proves at firſt ſweetiſh, but preſently becomes very bitter and nauſeous.

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AGARIC. As Agaric is an excreſcence from a very reſinous tree, it is natural for it to be rich in Reſin. We find in effect that it contains three fourths its weight of reſinous matter, and that the remaining fourth is a ſlimy, mucilaginous, earthy ſubſtance, ſo tenacious as ſcarce to be by any means diſſolved or divided; continuing, however treated with water, a tough gluey paſte. The purgative quality of Agaric reſides in the Reſin: To the glutinous matter we may attribute the dangerous conſequences, which, when given in ſubſtance, however corrected, it is apt to produce. No wonder that ſuch a coheſive indiſſoluble ſubſtance ſhould adhere, pertinaciouſly to the ſtomach and inteſtines, and occaſion gripes and other inconveniencies.

From eight ounces of very good Agaric, I obtained by rectified ſpirit, ſix ounces of reſinous extract: From the reſiduum, only two drams and two ſcruples of watery extract: The indiſſoluble tenacious matter weighed two ounces one dram and a half; ſo that there was upon the whole an increaſe of near half an ounce above the original weight of the Agaric, from a part of the menſtrua retained. On applying water at firſt, I got but bare three drams of extract; on treating the remainder with ſpirit, I gained near as much Reſin as when ſpirit was uſed firſt, namely five ounces and ſeven drams; the indiſſoluble matter weighed, when dry, two ounces two drams.

In reducing Agaric to powder, whether by the raſp or the peſtle, great care muſt be taken to avoid the fine duſt that flies off; which is not only apt to occaſion violent ſneezing, and inflammations of the eyes, but is likewiſe very prejudicial to the breaſt. Agaric cannot of itſelf be pulverized in a mortar, on account of its glutinous ſubſtance: The beſt way of obtaining a powder from it is, firſt to raſp, and then make it into a paſte with Mucilage of Gum Tragacanth: When this is thoroughly dry, great part of it may be beat into a fine powder, and by treating the remainder in the ſame manner, the whole will at length be got through the ſieve. It might be ſuppoſed, that as it is the mucilaginous part of Agaric itſelf that prevents its pulverization, the addition of freſh Mucilage would do more harm than good; but the Mucilage of Gum Tragacanth is of a quite different nature from that of Agaric, being ſoluble, harmleſs, when dry brittle, and rendering the Agaric alſo brittle and pulverable along with it. The troches of Agaric, a preparation formerly in eſteem, and ſtill retained in many diſpenſatories, are likewiſe moſt commodiouſly made up with this addition: When formed with only an infuſion of Ginger and Wine, as directed by the ancients, they do not dry; nor does Zwelfer's method, of making them up in froſty weather, ſucceed: A ſtrong froſt will indeed freeze them, but when the froſt is gone, they thaw into a pap again. In ſome diſpenſatories, a reſinous extract is directed to be prepared from this fungus by rectified ſpirit. An extraction may be made from it, of which a ſingle drop is capable of exciting vomiting (*d*).

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(*d*) *One drop let fall on the tongue, occaſions vomiting, and a diſguſt to food for a whole day.*] This is reported by Boulduc, of a ſpirituous tincture made from the cortical part of Agaric; and from him our author ſeems to have borrowed the obſervation. I have not found that the ſtrongeſt tinctures of the common Agaric of the ſhops produce any ſuch effect: To the taſte they are remarkably ſweet, and their ſweetneſs is very durable in the mouth, but becomes unpleaſant, though in no very great degree, before it goes off.

XIV. COLOCYNTH.

COLOCYNTH or Coloquintida is the fruit of a plant of the Gourd kind, growing plentifully in Perſia, differing from other Gourds in the leaves, being deeply cut in, but more remarkably in the quality of the fruit, which is ſo intenſely bitter as to have received the names of Gall of the Earth, Bitter Apple, Devil's Apple, *&c.* The medullary fungous part of the fruit, freed from the rind, is brought to us from Egypt and Aleppo.

Mr. Boulduc has given ſome experiments on Colocynth, with which mine do not entirely agree. He aſſures us, that on fementing it with Muſt, and then diſtilling the liquor, he obtained a bitter purgative ſpirit: I repeated the proceſs, uſing only Wine and Sugar inſtead of Muſt, which could not make any material difference; but without finding that the diſtilled ſpirit had the leaſt bitterneſs or purgative quality. Boulduc obtained from a pound of the pulp, only an ounce of ſpirituous extract, and from another pound only two ounces and a half of watery extract; whereas in my experiments, the ſpirituous extract amounted to three ounces and a half, and the watery to ſeven and a half. When ſpirit was applied at firſt, I gained from the remainder four ounces and a half of watery extract; and when water was firſt applied, the reſiduum yielded three drams forty-four grains to ſpirit.

The ſeeds differ remarkably from the pulp; whilſt the latter gives out half its weight of gummy and reſinous matter, the former yield but one eighth, nor is there much difference in the quantity of extracts, whether water or ſpirit are uſed firſt, the ſpirituous amounting only to eight ſcruples on the pound more than the watery. The ſpirituous extract of the ſeeds is manifeſtly unctuous or oily, though I could not ſeparate any Oil by expreſſion on committing ſeveral pounds to the operation at once. All the extracts made from the pulp are much bitterer than thoſe from the ſeeds, the firſt extracts bitterer than the ſecond, and the diſtilled liquors, both watery and ſpirituous, inſipid and inodorous.

The pulp of Colocynth is a violent purgative, apt to bring on convulſions and inflammations of the bowels. Many attempts have been made to correct it, by alcalies both fixed and volatile, vegetable acids, neutral ſalts, aromatics, *&c.* but the moſt prudent way is to refrain from it altogether, or to uſe only a watery extract made by long boiling: By long boiling with water, all the draſtic vegetables loſe their virulence and become mild. (See p. 268).

XV. BRYONY.

THERE are two ſorts of BRYONY one bearing red, the other black berries: The firſt is the moſt common about Berlin, climbing upon hedges, trees, old walls, *&c.* The roots of both ſorts are alike both in quality and appearance: They are moderately large, often forked, ſo as to be reſembled to the human body, and are by ſome cut into various figures and put off for mandrakes: They are externally of a yellowiſh colour, internally white and porous, of a bitteriſh, acrid, aſtringent taſte, and a diſagreeable ſmell, which is in great meaſure loſt by drying.

Bryony-root is a ſtrong purgative, and as ſuch has been recommended in hydropic caſes: It appears however not to be entirely ſafe. Mechoacan, an American root whoſe uſe had long been ſuperſeded by Rhubarb, was again had

BRYONY. had recourſe to in Germany ſome years ago, on the failure of Rhubarb from wars in Perſia: Mechoacan thus grew ſcarce, but preſently the ſhops were ſtocked, in leſs time than they could be ſuppoſed to have received ſupplies from America; and the roots looked alſo quite freſh, and different from what Mechoacan uſed to be. Theſe roots were probably Bryony, which in appearance does not ill reſemble Mechoacan. They were often productive of dangerous, and even fatal ſymptoms: In a few minutes after taking them, convulſions, a deprivation of the ſenſes, ſwelling of the eyes and head, frequently ſucceeded, not only in children, but in adults of the ſtrongeſt conſtitution. Platerus probably had experienced ſome ill effects from Bryony-root, or he would not have taken the trouble of drying and infuſing it ſo often in Wine, to fit it for medicinal uſe.

Boulduc, relates, in the French Memoirs, that this root contains only ſaline principles, and no Reſin. In my experiments a true Reſin was gained from it, but no Salt could be ſeparated, though it doubtleſs does contain a portion of ſaline matter, as the juice, added to a ſolution of Sulphur made with Quick-lime, occaſions a precipitation, accompanied with a fetid ſmell. It precipitates alſo ſolution of ſublimate, and in ſome degree that of blue Vitriol; but theſe precipitations are no mark of a Salt, and proceed from the feculent part of the juice.

A pound of the freſh roots yield near ſix ounces of juice, which retains much of the ill ſmell and taſte of the root: On ſtanding, it depoſites a white powdery matter, called *fecula* of Bryony, and recommended as a milder purgative than the root in ſubſtance. Two ounces of the dry root yielded with Water ten drams ſix grains of gummy extract, and afterwards with Spirit twenty-three grains of Reſin; five drams thirty-two grains remaining undiſſolved. It is pretty remarkable, that the reſiduum was in larger quantity when Spirit was applied firſt: By this method of application, I obtained, from two ounces, of reſinous extract two drams two ſcruples and a half, and afterwards four drams one ſcruple of a gummy one; eight drams two ſcruples and ſix grains remaining.

XVI. JALAP. JALAP is the root of a ſpecies of convolvulus, with leaves like thoſe of Ivy, but not ſo thick, and beautiful red flowers, which have this remarkable property, that they open in the night, and ſhut again on the leaſt appearance of the ſun; whence the plant is called by the French *Belle de nuit*, the beauty or fair one of the night: In rainy or cloudy days, the flowers open a little, but fall off the ſooner, as if day-light was injurious to them. The Jalap-plant is a native of the province Chalapa or Xalapa in New Spain, from whence its name is derived, and written, according to the pronunciation of different languages, *Jalapa* or *Jalapium*, *Gialappa*, *Chalapa*, *Xalapa*, *Zalapa*, &c. The roots raiſed in Europe have been found much weaker than the American.

Jalap is brought over in thin ſlices; of which the beſt are compact and hard, ſo as not to be broke by the fingers, ponderous, of a dark brown colour, of a gloſſy reſinous appearance, or at leaſt furniſhed with reſinous ſtreaks and circles, eaſily inflammable, of no ſmell, or a faint unpleaſant one, and of a ſlight acrid taſte: The fine duſt, which flies off in powdering them, provokes

sneezing. Those which are thoroughly resinous, are not liable to be worm eaten, the worms preying chiefly upon the gummy or mucilaginous parts, and not touching the resin, or at least not till these are consumed: Hence we may suppose the worm eaten roots to have been originally of a bad kind, produced in moist soils or rainy seasons, *&c.* and hence the worm eaten may be employed for making extracts equally with any other, the Resin being equal in goodness, though less in quantity. JALAP.

From sixteen ounces of good Jalap-root I obtained, by Spirit of Wine, five ounces and four scruples of resinous extract, and afterwards by Water two ounces and a half of a gummy one: On applying Water at first, I gained four ounces and a half of gummy extract, together with six drams of a resinous matter which fell to the bottom in evaporating the decoction; the remainder yielded, with Spirit, three ounces of Resin: The indissoluble part amounted in the first case to eight ounces three drams, in the latter to seven ounces six drams. By precipitating a spirituous tincture of the root with Water, I gained, from a pound, four ounces of pure Resin.

The inferior sorts of Jalap yield less resinous and more gummy extract: Such must have been that employed by Boulduc, who obtained, from sixteen ounces, only two ounces five drams and a scruple of resinous extract, but upwards of eight ounces and a half of a gummy one.

Jalap is a moderately strong, but a safe purgative, and wants none of the correctors which officious industry has contrived for it. It is given in doses of a scruple, with the addition of an equal quantity of vitriolated Tartar, and a few drops of Oil of Aniseeds. The pure Resin indeed is not to be ventured on without a corrector, as it gripes violently; but the proper correction does not consist in lessening its power, but in dividing and rendering it soluble in the animal fluids: For this purpose nothing answers better than grinding it with almonds, pine-nuts, yolk of eggs or other like substances, into the form of an emulsion. With regard to the different preparations of this root a solution of the Resin in Spirit of Wine, diluted with watery liquors by the mediation of Sugar or other substances that may prevent its separation, purges much more powerfully than the Resin given in a solid form however divided. A watery extract made from Jalap, after the action of spirit, promotes urine, but scarce proves at all purgative: This preparation was used by Borellus as an arcanum in dropsies. The watery extract made at first is both diuretic and weakly purgative. A compound extract made by Water and Spirit together, contains all the soluble parts of the root, and operates powerfully both by urine and stool.

It is observable of this root, that it has a notable degree of fermentative power; exciting this action in gross sweet vegetable juices, as melasses, and at the same time impregnating them with its purgative quality.

XVII. MATTALIST.

SOME years ago another purging root was brought from America under the name of MATTALISTA, of which, in Holland, there are two sorts, a coarser and a finer: One is said to be the produce chiefly of the French West Indies; the other of New Spain, and Aquacathan in New Gallicia. It is called in Ame-

MATTALIST. rica *Battata da purga.* The plant is as yet unknown. The only botaniſt I know of, that makes any mention of it, is John Bauhine, who calls it *Radix purgativa indica.* This root is chiefly recommended as a purgative in bilious complaints: It is nearly of a middle ſtrength betwixt Jalap and Mechoacan, being weaker than the firſt and ſtronger than the laſt. It yields a Reſin ſimilar to that of Jalap, but in leſs quantity; only ten drams, or an ounce and a half at moſt, being obtainable from ſixteen ounces of Mattaliſta.

XVIII. TURBITH. TURBITH is the root of a large convolvulus, growing in moiſt places near the ſea coaſts, in the iſland Ceylon, Suratte, Malabar, Goa, but moſt plentifully in Guzarotta, from whence the greateſt quantities of the roots are brought into Europe. The root is commonly about the thickneſs of the finger, though ſometimes twice or thrice as thick, browniſh on the outſide, whitiſh within, with a white ſpongy woody pith: Its taſte is at firſt ſweetiſh, afterwards acrid and diſagreeable.

The Indians formerly ſlit the roots longitudinally, and took out the woody matter. At preſent the roots are generally brought over pith and all, being only cut tranſverſely into oblong pieces, which are often found to be ſcorched at the ends: The uſe of the ſcorching is to ſear up the divided veſſels, and prevent the oozing out of the reſinous yellowiſh juice, with which the freſh roots abound. Albinus's ſuſpicion, that this juice is deſignedly extracted from them, before they come to us, appears to be groundleſs.

Sixteen ounces of Turbith root yielded with Water ſeven ounces three drams of gummy extract, and afterwards with Spirit only five drams forty-five grains of Reſin: Another pound, treated firſt with rectified Spirit, gave two ounces of reſinous; and afterwards with Water, ſix ounces eight ſcruples of gummy extract. The indiſſoluble earthy part amounts in both caſes to ſomewhat more than half the weight of the Turbith: Its quantity is ſomewhat greater when Spirit, than when Water is applied firſt——Water diſtilled from Turbith diſcovers a nauſeous ſmell and taſte, but no Oil.

Turbith root is a moderately ſtrong purgative: As ſuch the root in ſubſtance was formerly given, from a ſcruple to half a dram, and the Reſin to half a ſcruple; but ſince the introduction of Jalap, Turbith has been rarely uſed.

XIX. HERMODACTYL. HERMODACTYL is a root of the ſhape of a heart flatted; not at all of the ſhape of a finger, which its name ſeems to imply. It comes chiefly from Aleppo and Smyrna, by the way of Venice. The plant is wholly unknown: For the ſpecies of *Iris* given by Tournefort and Boerhaave, and the *Colchicum* by others, for the true Hermodactyl plant, have roots, according to their own account, entirely different from the officinal Hermodactyl.

We meet with Hermodactyls of various colours and ſizes, white, reddiſh, yellowiſh, browniſh, ſmall and large, wrinkled and ſmooth: The beſt are white both externally and internally, ſolid and compact, yet eaſily reducible into a powder, which looks like Wheat-flour, and does not greatly differ in taſte. This root is generally held a purgative, by ſome a ſtrong one: It does not appear, however, to have any activity at all. Hermann juſtly obſerves

ſerves that when dry, it is entirely if not altogether inert: But on what foundation he aſſerts that it is purgative when freſh, I know not, for he certainly never ſaw the freſh roots. HERMODAC.

The chemical compoſition of this root is pretty extraordinary. Two ounces of Hermodactyls, cut ſmall, yielded with rectified Spirit a dram and a half of reſinous extract, and afterwards with Water an ounce of gummy extract; ſix drams and a half remaining undiſſolved. If we invert the order, and apply Water at firſt, inſtead of an ounce of gummy extract, we obtain but half an ounce and three grains, and yet the reſiduum gives out nothing to rectified Spirit, how long ſoever the digeſtion is continued: This reſiduum weighs one ounce and a half, and does not look near ſo dark coloured as that from which more has been extracted, but ſemitranſparent, almoſt like horn. Theſe remarkable differences in the effects of Water and Spirit, according as either is applied firſt to the root, may deſerve further enquiry.

CLASS III.

Gummy-Reſinous Vegetables.

GUMMY-Reſinous ſubſtances are thoſe, whoſe medicinal activity or colour reſide in ſuch a combination of reſinous and gummy matter, as to be extracted by Water, ſometimes more perfectly than by Spirit, and not only by boiling but by infuſion in Water. Moſt of the bodies of this claſs, after repeated infuſion in Water, yield ſtill a portion of reſinous matter to rectified Spirit: But the Reſin thus obtained has generally little or nothing of the diſtinguiſhing taſte or virtue of the ſubject. To this diviſion belong ſome of the emetics, as Tobacco, Aſarum, Ipecacoanha, Arnica; a few of the purgatives, as Sena, Rhubarb, Rhapontic; moſt of the aſtringents, as Tormentil and Galls; moſt of the bitters, as Gentian, Centaury, Carduus; ſome of the colouring drugs, as Turmeric; with many others of weaker or more compounded qualities. GUMMY-RESINOUS.

I. TOBACCO.

TOBACCO (*Petum*, *Nicotiana*, *Herbà medicea*, *&c.*) was firſt diſcovered in the iſland *Tobago*; brought into Europe, in the year 1559 or 1560, by M. *Nicot* the French ambaſſador in Portugal; and preſented to Queen Catherine *de Medicis*. It is now become the object of very extenſive manufactures, and cultivated in large quantity by the European colonies in America, as alſo in ſome parts of Europe. There are different ſpecies of the plant, and great differences alſo in the qualities of one ſpecies according to the ſoil and climate: ſtill further differences are occaſioned in the prepared Tobaccos and Snuffs, from the manner of preparation, and the additions made uſe of for communicating colour, flavour, *&c.*

The leaves of this plant, taken internally, prove virulently emetic, cathartic, and narcotic: Even in the common forms in which they are employed in ſuch immenſe quantities, they generally at firſt diſorder the conſtitution, till

TOBACCO. habitual uſe, which ſubdues many noxious things, has rendered them perhaps innocent, and perhaps even neceſſary. Diſtilled in a retort without addition, they yield an acrid empyreumatic Oil, which has been found, from repeated trials, to be poiſonous to ſundry animals: It is probably on this Oil that the effects of the ſmoke of Tobacco depend, for when the plant is ſet on fire, its native qualities are deſtroyed.

Tobacco loſes its virulence by long coction in Water: Though all the active parts of the herb are extracted by the Water, yet the extract left upon evaporating the liquor, taken in doſes of four or five grains, proves mildly aperient and anodyne, and is ſaid to be of great ſervice in diſorders of the breaſt: The longer the coction is continued, a ſuitable quantity of Water being added for that purpoſe, the milder is the extract.

I analyſed three ſorts of Tobacco, the American caniſter Tobacco, the Dutch leaf, and the dried leaves of our own growth. An ounce of the caniſter, treated firſt with Water, gave four drams thirty grains of extract; the ſame quantity of the Dutch, four drams; of our own four drams fifty grains: From the reſiduum of the firſt, rectified Spirit extracted thirty grains; from that of the ſecond, ſixty; and from that of the third, thirty——An ounce of the caniſter ſort, treated firſt with rectified Spirit, yielded one dram thirty grains; the ſame quantity of the Dutch, two drams twenty grains; and an ounce of ours, two drams thirty grains: From the reſiduum of the firſt, Water extracted three drams thirty grains; from that of the ſecond, two drams forty grains; of the third, two drams thirty grains. The indiſſoluble earthy matter amounted, in each of the experiments, to three drams.

The ſpiritous extracts, made from all the ſorts, were ſtronger than the watery: That of the caniſter ſort was notably pungent on the tongue; of the Dutch, only bitteriſh, without any acrimony: the ſpirituous extract of ours taſted ſomewhat pungent, but the watery only bitter. The ſpirituous extracts of all the ſorts are of a fine green colour, the watery of a yellowiſh brown. The diſtilled Waters and Spirits have no taſte or ſmell: Bohn, however, pretends that the diſtilled Water, eſpecially if drawn from the juice of the herb, will occaſion vomiting if taken to the quantity of an ounce or two.

II. ARNICA. ARNICA, *Arnica plauenſis*, is a ſpecies of Doronicum (*Doronicum plantaginis folio alterum C. B.*) with leaves like thoſe of Plantane, and yellow radiated flowers. The flowers and leaves are emetic or purgative: An infuſion of them is ſaid to be remarkably ſerviceable for reſolving coagulated blood from falls, *&c.* and in obſtructions of different kinds: See the *Acta Berolinienſia*, the Breſlau Collections, and the Diſſertations of Albertus and Buchner on this plant.

Two ounces of the flowers yielded with rectified Spirit three drams of extract; the ſame quantity of the leaves only two and a half: With Water, the leaves afforded moſt, two ounces giving five drams and a half, whilſt the ſame quantity of the flowers gave but five drams. The watery extract appears to be the mildeſt, and oftentimes does not occaſion either vomiting or nauſea. Neither the leaves nor flowers have any remarkable ſmell, or give over any thing in diſtillation.

III. IPECACOANHA, called by ſome, from its medical virtue, and the place of its growth, the American or Peruvian antidyſenteric, and Brazilian root, is the root of a plant ranked by Ray as a ſpecies of Herb-paris, and diſtinguiſhed by the name of Brazilian Herb-paris bearing a number of berries.

Ipecaco.

There are four ſorts of Ipecacoanha; grey, brown, white, and yellow. The two firſt are thoſe which are moſt common in the ſhops: The third is rarely brought into Europe; and the fourth is mentioned only by Sherard, as received in a preſent from Tournefort. With regard to the two laſt I ſhall obſerve only, that the yellow is merely purgative, and does not, like the others, occaſion any vomiting: And that the white vomits more mildly than the grey or the brown.

Of the grey and brown, ſome prefer the one, and others the other; in England, they are uſed promiſcuouſly. It is in general ſuppoſed, that the grey operates with greateſt mildneſs: This however depends, not upon the root being the grey or the brown ſort, but on its being good of the kind; I have ſeen very good and very bad Ipecacoanha of both ſorts.

Both the brown and the grey agree in their external figure, being about the thickneſs of a quill, very unequal and knotty: They have a bitteriſh ſomewhat acrid taſte, but diſcover little or no ſmell when the quantity examined is ſmall: In large quantity, they yield a diſagreeable ſmell, and in pulverization, a kind of muſty one. The larger, compact roots, of a reſinous appearance, are the beſt: The ſlender, blackiſh brown, and thoſe which are full of fibres, the worſt. There grows in America another plant, called there *Caapia*, whoſe roots greatly reſemble Ipecacoanha, and are frequently brought over in its ſtead: This root is externally of a yellowiſh colour: It is greatly inferior in virtue to the true Ipecacoanha, and therefore to be guarded againſt.

Boulduc relates, that the brown Ipecacoanha does not contain ſo much ſoluble matter as the grey: Probably the brown he employed was of a bad kind, for I have not obſerved any ſuch difference: Differences indeed there are, and great ones, but they depend wholly, as already mentioned, on the root being good or bad of the ſort. Sixteen ounces of good Ipecacoanha yielded with ſpirit three ounces of reſinous, and afterwards with water four ounces wanting two ſcruples of watery extract, eight ounces and ſix drams remaining undiſſolved. Another pound of the ſame, treated firſt with water, gave five ounces of gummy, and afterwards with ſpirit ten drams of reſinous extract; the indiſſoluble part amounting to two ſcruples more than in the former experiment——On the other hand, a pound of very bad Ipecacoanha yielded only an ounce and a half of reſinous, and the ſame quantity of gummy extract; and on inverting the order of applying the reſpective menſtrua, two ounces ſix drams of gummy, and only a dram and a half of reſinous extract.

Ipecacoanha is one of the mildeſt and ſafeſt emetics. Its firſt introduction into Europe was in the time of Louis XIV. of France, by one Grenier a French merchant, who brought an hundred and fifty pounds from Spain, of which trials were made in the Hotel-dieu. Helvetius firſt diſcovered, to his

Moſt

IPECACAO. Moſt Chriſtian Majeſty, its antidyſenteric virtues, for which he received a reward of a thouſand louis-d'ors, as he informs us himſelf in his Treatiſe of Diſeaſes and Specific Remedies. Experience has ſince ſhewn that it is often of great ſervice in dyſenteries, but not always. The French phyſicians give it in ſmall doſes, frequently repeated; if it produces no amendment by the time that three drams have been taken, they deſiſt from any further uſe of it. They employ it ſometimes in the form of glyſter, but find that when thus managed, it does not anſwer ſo well as when ſwallowed.

Some have ſuppoſed that the emetic virtue of Ipecacoanha reſides in its gummy parts, the cathartic in its reſinous, and the aſtringent in its earthy. Thus much is certain, that neither the gummy nor the reſinous parts, ſeparately or conjointly, are equally ſerviceable in dyſenteries with the root in ſubſtances, and that infuſions of it in Wine are effectually emetic.

IV. ASARUM. THE roots of ASARUM ſeem to be nearly allied to Ipecacoanha. Though violently purgative and emetic when freſh, yet by keeping for three or four years, and even by bare drying, they become far milder, ſcarcely vomiting or purging at all, but proving powerfully reſolvent. An extract made from them by long boiling with water, loſes entirely the purgative virtue of the root, and becomes reſolvent, diaphoretic, and diuretic. Aſarum roots agree likewiſe with Ipecacoanha in their chemical analyſis.

V. SENA. SENA is a ſmall ſhrub, with ſharp-pointed leaves ſomewhat like thoſe of Liquorice, roſaceous flowers, and flathooked pods or ſeedveſſels: It grows chiefly in Syria, Perſia, Arabia and Egypt: The leaves and pods are brought to us immediately from Alexandria, whence the name *Sena Alexandrina*. A ſpecies of Sena is found alſo in Italy, but much inferior in virtue to the oriental: The leaves of this are readily diſtinguiſhed from thoſe of the other, by their being not pointed but broad at the end almoſt in ſhape of a heart. Pomet mentions three ſorts of the foreign Sena; the firſt or beſt is called *Sene d' Alexandrie*, or *Sene de la Palte*, that is Tribute-ſena, the Turks paying their tribute in this beſt ſort; the two others are *Sene de Seyde* or *de Tripoli*, and *de Moca*. They are all the produce of one ſpecies of plant, differing only according to the ſoil and climate. The beſt Sena-leaves are of a fine green colour, free from ſpecks, ſmooth and ſoftiſh to the touch, and thoroughly dry, of a conſiderable degree of ſmell, and a bitteriſh ſomewhat nauſeous taſte. They are often expreſſed in preſcriptions [in Germany, *&c.*] by the letters *S. S. S.* i. e. *Sena Sine Stipitibus*, Sena picked from the ſtalks.

Sena is one of the milder purgatives. Its common doſe is two drams, infuſed in water: It is rarely given in ſubſtance, on account of its bulkineſs. The inconveniencies complained of in this medicine are, that it is apt to occaſion a nauſea, ſickneſs, and flatulencies; which ſome erroneouſly aſcribe to the ſtalks and pods. The beſt correctors are the ſtarry-headed Aniſeeds, Cinnamon, Cloves, and Creme of Tartar. Mr. Marchand relates, in the French Memoirs for the year 1701, that the dry leaves of the greater Waterfigwort (*Scrophularia aquatica major*, *C. B.*) wholly take off its ill ſmell and taſte, equally with the *Iquetaya* celebrated for that purpoſe by the Brazilians.

An

An ounce of choice Sena, treated with freſh parcels of rectified Spirit of Wine, yielded two drams twenty-three grains of reſinous extract; and afterwards with water, two drams two ſcruples of gummy extract, three drams and three grains remaining undiſſolved. Another ounce, treated firſt with water, gave four drams and half a ſcruple of gummy, and afterwards with ſpirit only twenty-eight grains of a reſinous extract, which appeared to contain ſome groſs oily matter, and hence was difficultly reduced to dryneſs; the reſiduum weighed three drams and a ſcruple. Valentini muſt have operated very incurioufly in obtaining but two ounces of extract from a pound: I gained near ten, reckoning the watery and ſpirituous together; and above eight of watery extract alone. SENA.

In diſtillation rectified ſpirit brings over nothing; the diſtilled water is impregnated with the ſmell of the Sena, but diſcovers no appearance of eſſential Oil. The activity of the Sena is greatly weakened by evaporation, eſpecially if the proceſs is performed by a boiling heat in an open veſſel, the extract proving far leſs purgative than an equivalent quantity of the infuſion which it was made from. The reſinous extract is more ungrateful in taſte than the watery, and contains the green colour of the leaf.

VI. RHUBARB.

RHUBARB, *Rheum*, *Rhabarbarum*, (ſuppoſed to have been ſo called from its growing on the banks of the river *Rha*, now Wolga, in the *barbarous* country Ruſſia) is at preſent brought only from China: Part comes by land through Ruſſia, and part by ſea from the Eaſt-Indies. It is the root of a plant which agrees with the Docks in all its botanic characters but the flowers; thoſe of the Docks conſiſting merely of threads or ſtamina, whilſt thoſe of the Rhubarb plant are furniſhed each with a ſingle petalum ſhaped like a bell and divided into ſeveral ſegments about the edges. The root is large, ſometimes oblong and ſometimes roundiſh, of a dark-browniſh colour on the outſide with black and reddiſh ſtreaks, internally reddiſh-yellow and full of a juice of the ſame colour. It is cured by cutting off the ſmall fibres and the dark-coloured cortical part, not all at once but at intervals, the ſide which is firſt pared being laid uppermoſt till the juice dries and concretes; afterwards boring a hole through the root, and hanging it up in a ſhady place till thoroughly dry.

This root is exceeding ſubject to ſpoil, and to be preyed upon by worms, unleſs kept perfectly dry. The dealers frequently fill up the wormholes with a maſs compoſed of powdered Rhubarb and Mucilage of Gum Tragacanth; and colour the old decayed roots with an infuſion of Rhubarb, Turmeric, or other colouring drugs. When Rhubarb looks very freſh and fair externally, or of a high yellow colour, we may ſuſpect that it has ſuffered theſe abuſes. Good Rhubarb is not of an uniform yellow, but variegated with browniſh and blackiſh ſpecks, veins and circles: Internally it is reddiſh, ſtreaked and marbled as it were like a Nutmeg: It is of a ſpongy texture, yet moderately heavy, firm, and not eaſy to break: It readily ſtains the moiſt hand, and tinges the ſpittle on being chewed, of a deep yellow: Its ſmell is unpleaſant, its taſte diſagreeably bitteriſh. The roots of middling ſize are better than the very ſmall or the very large ones: Some prefer the Ruſſia or Turkey, and ſome the Eaſt-India

Rhubarb,

RHUBARB. Rhubarb, but both ſorts, if equally well cured and preſerved, are of equal goodneſs (*e*).

An ounce of fine Rhubarb, reduced into groſs powder, yielded with highly rectified Spirit of Wine three drams of extract, and afterwards with water three drams wanting half a ſcruple; the reſiduum weighed two drams twelve grains. On applying water at firſt to another ounce of the ſame, I obtained about as much extract as had been gained in the former caſe by the water and ſpirit both, namely ſix drams all but half a ſcruple; the reſiduum gave out five grains to rectified ſpirit, two drams eight grains remaining undiſſolved.

Thus we find that water extracts nearly all the ſoluble part of Rhubarb, but ſpirit little more than one half of it; a proof that this root contains a much larger proportion of gummy or mucilaginous than of reſinous matter: Hence ſpirituous tinctures of it are not precipitated or rendered milky by the addition of water, like the tinctures of moſt other vegetables. I examined alſo the ſolubility of the aqueous and ſpirituous extracts, each in its oppoſite menſtruum; out of ſixty grains of the ſpirituous extract, water diſſolved fifty-five, but out of the ſame quantity of the watery, rectified ſpirit diſſolved only eighteen.

The yellow colour of Rhubarb is remarkably leſs deſtructible than many other vegetable yellows: Aqua fortis and other acids, which deſtroy the colour of infuſions of Saffron, Turmeric, *&c.* make no change in that of Rhubarb, or at moſt render it only turbid: Volatile ſpirits heighten the colour, and incline it to red; fixed alcaline Salts have this effect in a greater degree. Solutions of green Vitriol, and other Chalybeate liquors, change infuſions of Rhubarb to an inky blackneſs; a mark that this root is poſſeſſed of an aſtringent quality.

In effect Rhubarb uſed as a medicine diſcovers, beſides its mild purgative virtue, a manifeſt aſtringency; whence its uſe in laxities and debilities of the viſcera, and in alvine fluxes. The powdered root acts much more effectually as a cathartic than infuſions, tinctures, extracts or other preparations: It may be taken to the quantity of a dram.

It is ſingular of this root, that the ſpirituous extract does not purge, but that the extract made by water after ſpirit does; as if its purgative quality reſided chiefly in a combination of gummy and ſaline matter. Mr. Boulduc relates, that twenty-four grains of the powder purge as much as an infuſion of an hundred and eight grains, and as much as ſeventy-two grains of the watery extract;

(*e*) *Rhubarb—both ſorts equal in goodneſs.*] There are ſome differences in the qualities of the two ſorts of Rhubarb: Perhaps one may be beſt adapted for ſome purpoſes, and the other for others. The Eaſt-India Rhubarb appears manifeſtly the ſtrongeſt, and the Turkey ſort has moſt of an aromatic flavour. Tinctures drawn from both, with equal quantities of rectified Spirit of Wine, have nearly the ſame taſte; but on drawing off the menſtruum, the extract left from the tincture of the Eaſt-India ſort proves conſiderably the ſtrongeſt. The Eaſt-India Rhubarb is more ſolid and compact than the other, and ſeems to have been taken up at a ſeaſon when the root is leſs watery: It does not appear to have required ſo much care in the drying, as the pieces never have a hole through them like thoſe of the others: From its greater ſolidity, it is leſs ſubject to decay in keeping.

The Rhubarb plant has of late been naturalized to our own climate: But trials have not yet been made, how far the roots raiſed among us, agree or diſagree in quality with thoſe of foreign growth.

extract, its purgative principle not being eaſily taken up by water any more than by ſpirit, and being in great part changed or deprived of its virtue during the evaporation. It ſeems as if this principle was in part volatile: Herman obſerves that in ſome perſons, the bare ſmell of Rhubarb opens the belly; and Borrichius, that even the diſtilled water is not only of a nauſeous taſte, but purgative. RHUBARB.

Some endeavour to improve the virtue of Rhubarb for particular purpoſes, by torrefaction: The powdered root is placed on an iron plate, over a gentle fire, and kept continually ſtirring with an iron ſpatula, till it loſes its peculiar ſmell, and changes its yellow colour to a brown. By this means its purgative quality is greatly diminiſhed, and its aſtringent one ſuppoſed to be increaſed: The preparation however is at beſt an injudicious one, as all that can be expected from it may be obtained with greater certainty, by joining to Rhubarb a due proportion of ſome aſtringent or corroborant of known efficacy, as Peruvian-bark or Caſcarilla. It is obſervable of this root, that it tinges the urine of a deep yellow or reddiſh colour.

VII. MONKS RHUBARB. Rhapontic.

THE roots of certain Docks and ſome other plants raiſed in Europe approach to Rhubarb in appearance, participate in ſome degree of its medicinal virtues, and are ranked among the officinal ſimples, under the names of MONKS RHUBARB and RHAPONTIC. The common Monks Rhubarb is the root of the *Lapathum hortenſe latifolium, C. B.* broad-leaved garden Dock or Patience (*f*). The Rhapontic of the phyſick garden of Berlin, and which of all the ſorts comes the neareſt to the true Rhubarb, is the *Lapathum folio rotundo alpinum, J. B. & Tourn.* round-leaved mountain or garden Dock.

Sixteen drams of this root yielded with rectified ſpirit ſeven drams and a ſcruple of extract, and afterwards with water three drams and a half, five drams and half a ſcruple remaining undiſſolved. On inverting the procedure, and treating the ſame quantity of the root firſt with water and afterwards with ſpirit, I obtained ten drams two ſcruples of watery, and one ſcruple of ſpirituous extract; the reſiduum weighing five drams and a few grains.

The extracts made at firſt, whether by water or by ſpirit, contain the active matter of the Rhapontic, both the ſecond extracts having little or no taſte. The yellow colour of the root is more perfectly taken up by ſpirit than by water, and more concentrated in the ſpirituous than in the watery extract. The ſpirituous extract is alſo ſtronger in taſte than the watery: On firſt taſting, they both prove ſweetiſh, but ſoon after diſcover a degree of pungency.

VIII. ARNICA.

ARNICA SCHWEEDENSIS ſomewhat reſembles in its flowers the *Arnica* formerly mentioned, and has by ſome been miſtaken for it. It is never-

(*f*) *Monks Rhubarb.*] The roots of this plant, though they have pretty much of the appearance of true Rhubarb, come far ſhort of it in quality: they nauſeate the ſtomach, and though given in double the doſe of Rhubarb they ſcarcely produce any evacuation. It is obſervable that the young ſhoots in the ſpring approach in taſte to ſome ſorts of apples: Of late, they have been employed in that early ſeaſon, as a ſuccedaneum to apples for culinary purpoſes.

ARNICA. nevertheleſs a quite different plant, a ſpecies not of *Doronicum* but of *Aſter*, named by Tournefort *Aſter pratenſis autumnalis conyzæ folio.* It differs alſo greatly in quality, being not at all emetic or purgative, but aſtringent, and hence recommended in alvine fluxes. Nor does it yield ſo much ſoluble matter to watery or ſpirituous menſtrua: An ounce of the flowers gives hardly a dram of reſinous, and about two drams of gummy extract.

IX. TORMENTIL. TORMENTIL, *Tormentilla Sylveſtris, C. B.* is a low creeping plant, with ſmall indented leaves ſtanding ſeven together, and yellow tetrapetalous flowers, growing ſometimes in meadows, but chiefly in ſandy and hilly places. It is called Tormentil from its being ſerviceable againſt fluxes with *Tormina* or Gripes; from the number of its leaves it is named *Heptaphyllum*, Septfoil.

The root, which is the only part made uſe of, is ſlender, never thicker than the little finger, very knotty, irregular, and variouſly bent, externally of a brown colour, internally reddiſh with white or yellow ſtreaks, of a ſomewhat aromatic aſtringent taſte, with ſcarcely any ſmell. It is employed as a mild aſtringent and corroborant: By ſome it has been ſubſtituted to Peruvian-bark in the cure of intermitting fevers: By ſome it has been mixed with a little emetic Tartar as a ſuccedaneum to Ipecacoanha in dyſenteries.

This root is extremely hard and compact, and does not readily part with its active matter on digeſtion either in water or in ſpirit: It does however, by degrees, give out the whole of its virtue to both menſtrua. The ſpirituous extract is much more ſtyptic, and of a deeper red colour than the watery; not that ſpirit takes up more from the root than water does, but from its taking up leſs of the inert matter, whence the active parts are more concentrated: An extract made by ſpirit after water is as inſipid as that made by water after ſpirit.

From two ounces of the root cut in ſmall pieces, I obtained by rectified ſpirit ſix drams five grains of extract, and afterwards by water two drams two ſcruples and a half; the reſiduum weighing ſeven drams five grains. The ſame quantity, treated firſt with water, gave nine drams and a half of gummy extract, and afterwards with ſpirit only eight grains of a reſinous matter; the reſiduum amounting to ſix drams twenty-two grains. In diſtillation, rectified ſpirit brings over nothing; the diſtilled water diſcovers a little of the aromatic taſte of the Tormentil-root, and a ſlight agreeable ſmell, ſomewhat like that of Roſewood.

X. GALLS. GALLS are excreſcences found upon the Oak-tree, produced by an inſect, which wounds the young branches in the ſpring, and depoſites its eggs in the puncture: The tear which iſſues from the wound, gradually increaſed by acceſſions of freſh matter, forms a covering to the young inſect, which at length eats its way out, leaving the Gall hollow. When the Gall has no perforation, the inſect is found dead within it. Sometimes alſo, after the eſcape of its own, it is occupied by other inſects.

There is a great variety of Galls, whitiſh, yelloviſh, greeniſh, browniſh, reddiſh, greyiſh and blackiſh, ſmall and large, round and irregular, light and heavy, ſmooth, and with protuberances on the ſurface. The ſmall, blackiſh, protuberant, and ponderous, are the beſt. Theſe are the produce chiefly of the

the Turkiſh dominions, and brought immediately from Aleppo, Tripoli, and Smyrna: Thoſe of Europe are greatly inferior. GALLS.

As all the parts of the Oak-tree are notably aſtringent, it is natural for this excreſcence to poſſeſs that quality; and in effect Galls are found to be one of the ſtrongeſt of the vegetable ſtyptics: Hence they ſtrike a deep black colour with ſolution of Chalybeate Vitriol (See page 181.) and are employed in conjunction with that Salt, preferably to other vegetables, for dying cloth black, and for making ink; theſe are the principal uſes to which they are applied. They are rarely uſed medicinally, unleſs as an external ſtyptic. Monſ. Reneaume, in the French Memoirs for the year 1710, recommends them internally againſt intermitting fevers, in preference even to Peruvian-bark, as being free from the bitterneſs of that medicine, occaſioning no heat, and not requiring to be given in ſo large doſes: It is proper to obſerve however, that great caution is requiſite in the exhibition of ſtrong aſtringents in that diſorder.

Extracts made from Galls, both by water and by ſpirit, poſſeſs the whole of their aſtringency, but the ſpirituous extract is ſtronger and more diſagreeable than the watery. An extract made by ſpirit after water has no particular taſte, but an extract made by water after ſpirit taſtes manifeſtly ſaline, and exhibits ſome ſmall ſhining particles of an actual Salt.

Sixteen drams of Galls groſsly powdered, yielded with water fourteen drams of extract, and afterwards with ſpirit only four grains; the reſiduum weighing two drams. The ſame quantity, treated firſt with ſpirit and afterwards with water, gave twelve drams two ſcruples of ſpirituous, and four ſcruples of watery extract; the reſiduum weighed half a ſcruple more than in the former caſe.

XI. GENTIAN.

GENTIAN ſaid to be ſo called from Gentius a King of Illyria who is ſuppoſed to have firſt diſcovered it, grows in ſome of the mountainous parts of Switzerland, Hungary, France, *&c.* from whence the ſhops are ſupplied with the dried roots. The leaves are ſomewhat like thoſe of White-hellebore, the flowers monopetalous and yellow; whence the plant is named by John Bauhine *Gentiana vulgaris major ellebori albi folio*, and by Caſpar Bauhine *Gentiana major lutea*. The root is externally of a brown colour, internally yellow, with a pith in the middle not of the woody kind but rather more ſpongy than the reſt of the root; the older and larger the root, the more porous; the younger and ſlenderer, the more compact: The beſt roots are thoſe which are of a middling ſize and a lively yellow colour.

This root has a light not diſagreeable ſmell, and an intenſely bitter taſte. It is an excellent ſtomachic and corroborant: By ſome it is greatly recommended in intermitting fevers, and diſtinguiſhed by the title of European Kinkina. The ſurgeons frequently make uſe of it in old wounds, ulcers and fiſtulæ; not ſo much however, as ſome pretend, from any peculiar quality of obtunding acrimonious juices, as from its imbibing moiſture, and ſwelling thereby, and thus dilating the orifice or keeping the lips aſunder.

Sixteen drams of this root yielded with rectified ſpirit ſix drams and a half of reſinous extract; and afterwards with water three drams and a half of a gummy one: The ſame quantity, treated firſt with water and then with ſpirit,

GENTIAN. gave nine drams of gummy and only a ſcruple of reſinous extract: The reſiduum in the firſt caſe weighed ſix drams, in the latter two ſcruples more.

The extract made at firſt by ſpirit contains all the bitterneſs of the Gentian, and is the moſt active preparation of it: The gummy matter extracted afterwards with water is inſipid. The extract made at firſt by water is indeed very bitter, but leſs ſo than the ſpirituous, both on account of its quantity being larger, and a part of the bitter matter being ſtill left in the root; for the Reſin gained from the reſidue diſcovers a manifeſt bitterneſs. In diſtillation, ſpirit brings over nothing: The diſtilled water has a ſlight impregnation from the Gentian, but too inconſiderable to deſerve any notice (*g*).

XII. WHITE DITTANY. WHITE or BASTARD DITTANY, *Dictamnus albus vulgo ſive fraxinella, C. B.* grows in the mountainous parts of Italy, Hungary, *&c.* produces irregular polypetalous flowers, and leaves like thoſe of the *Fraxinus* or Aſh-tree. In the ſhops we meet with the cortical part of the root, which is of a whitiſh colour and a bitter taſte without any ſmell; the inner, woody, inſipid pith being taken out. The ſmall young roots, about the ſize of a quill, are much the ſtrongeſt.

This root contains a much larger proportion of gummy than of reſinous matter: Out of ſixty drams, water takes up ſix drams two ſcruples and a half; rectified ſpirit only four ſcruples two grains: The matter left by ſpirit gave five drams two ſcruples and two grains to water; but the matter left by water gave to ſpirit no more than half a ſcruple. The extract made at firſt by ſpirit is the moſt active preparation: The watery extract is far leſs bitter. The diſtilled water has ſome little taſte; the diſtilled ſpirit has no other taſte or ſmell than pure Spirit of Wine. This root has been ranked among the ſtomachics, alexipharmics, and anthelmintics; but it does not promiſe, however, any great virtue (*h*).

IN

(*g*) *Gentian.*] The Gentian uſed among us comes chiefly from Germany. Some years ago, a quantity was brought over which had an admixture of pieces of a different root, the uſe of which occaſioned violent diſorders, and in ſome inſtances death. This poiſonous root is readily diſtinguiſhed from Gentian by its being externally of a paler colour, and internally not at all yellow, but white: Chewed, it diſcovers nothing of the bitterneſs of Gentian, nor any other than a ſlightly pungent mucilaginous taſte.

Phyſicians were at that time at ſome loſs for a ſuccedaneum to Gentian; and indeed among the great number of vegetable bitters, we ſcarcely know of one that poſſeſſes the valuable qualities of this root, which is not only a ſtrong but an almoſt ſimple flavourleſs bitter. Chemiſtry however can eaſily purify the other bitters, and bring them to the ſame ſtate with that of Gentian: It can diſſipate their offenſive flavour, and preſerve the bitterneſs unhurt. If the dry leaves of common Wormwood be boiled in water, and the decoction boiled down to the conſiſtence of an extract, the diſguſtful matter of the Wormwood will all exhale in the boiling, and may be caught and collected by itſelf, whilſt the extract proves ſimply bitter, as ſtrong, as flavourleſs and inoffenſive, as an extract made from Gentian. This extract gives out its pure bitterneſs to rectified Spirit of Wine as well as to water.

(*h*) *White Dittany.*] The root of this plant yields no eſſential Oil in diſtillation, but the leaves a conſiderable quantity: The Oil has a ſtrong unpleaſant ſmell, ſomewhat of the Tere-

XIII. LESSER CENTAURY.

IN the two foregoing plants, the bitterneſs is confined to the roots: In the LESSER CENTAURY it is only the herb, or the part which ariſes above ground, that is bitter. Centaury is ſo called from *Centum* and *Aurum*, on account of its excellent virtues; and agreeably to this derivation, it is named by the Germans *Tauſend-gulden-kraut*. The ſpecies here intended is the *Centaurium minus*, *C. B.* It grows chiefly in dry ſandy grounds, and if the ſeaſon proves alſo dry, is extremely apt to fail: As in ſome ſummers we meet with very little, it is proper to lay in a ſtock in thoſe years when it is plentiful. The leaves are ſlender, furniſhed with three ribs like thoſe of Plantane, but ſmaller and narrower: There is commonly a buſh of leaves upon the ground, but on the ſtalk no more than twelve, which ſtand in pairs. The flowers are numerous, and often cluſtered together into the form of Umbels: They conſiſt of ſingle, purpliſh red, funnel ſhaped petala, which ſhut in the night, and open in the day-time. The ſhops are generally ſupplied with the herb in flower, tied up in bundles, though the flowers have little or nothing of the bitterneſs for which the plant is valued.

Theſe flowers, like other red ones, loſe their colour on being kept: It is obſervable that the change begins in the lower narrow part of the flower next the cup, and proceeds gradually upwards, the upper edge retaining its colour longeſt. The leaves of Leſſer-centaury are almoſt ſimply bitter, with very little of any ſmell or particular flavour: They are excellent ſtomachics and corroborants in intermitting fevers, cachexies, dropſies, *&c.* Maurice Hoffman relates, in the *Ephemerides naturæ curioſorum*, that he cured two hydropic caſes with powdered Centaury alone, and hence gives the plant the name of *Gentiana hydropica*.

The bitterneſs is taken up both by water and by ſpirit; the tincture and extract made with the latter are the ſtrongeſt. An ounce of the dry tops yielded with rectified ſpirit three drams two ſcruples of reſinous, and afterwards with water two drams one ſcruple of gummy extract; the reſiduum weighed two drams, or one fourth of the quantity of Centaury employed. Another ounce, treated firſt with water, gave five drams one ſcruple of gummy extract, and afterwards with rectified ſpirit two ſcruples of Reſin; the reſiduum weighing, as before, juſt two drams. The green colour of the herb reſides in the reſinous principle, being extracted by rectified ſpirit and not by water. In diſtillation, neither water nor ſpirit receive any conſiderable impregnation.

XIV. CARDUUS.

CARDUUS BENEDICTUS (*Cnicus ſylveſtris hirſutior ſive Carduus Benedictus*, *C. B.*) is another bitter plant, whoſe bitterneſs is confined chiefly to the leaves. Four ounces of dry Carduus leaves yielded with rectified ſpirit four drams and a half of reſinous extract, and afterwards with water ſix drams and a half of a gummy one, the indiſſoluble earthy part amounting to two ounces and five drams. The ſame quantity, on applying firſt water and afterwards Spirit of Wine, gave ten drams of gummy extract, and only one dram of Reſin.

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Terebinthinate kind, like that of the herb itſelf. It is ſaid that when the herb is in vigour, its effluvia in very hot dry weather, take fire on the approach of a candle, and form a large lambent flame which ſpreads all over the plant.

CARDUUS. The fresh plant has a weak not agreeable flavour, which arises in distillation with water, especially if the Carduus is previously fermented for a little time: In drying, it loses its flavour, and in this state gives over nothing. The expressed juice, duly depurated and evaporated to the thickness of a syrup (See page 279.) yields, on standing, saline crystals, approaching to the nature of Tartar.

XV. HORHOUND. THE fresh leaves of HOREHOUND (*Marrubium album vulgare, C. B.*) have a bitterish taste, with a peculiar not disagreeable sweetish smell, resembled by some to that of Citrons, by others to that of Musk, but which seems to approach nearer to that of rectified Spirit of Wine.

Their smell is dissipated in drying, and elevated by water in distillation, but not by pure spirit; the distilled water gives no appearance of any oily matter. The bitterness remains uninjured in both the extracts; the spirituous is much the strongest, and in smallest quantity; it possesses the true specific taste and flavour of the herb, together with its green colour.

An ounce of the dried leaves yielded four drams and a half of watery, and afterwards half a dram of spirituous extract: Rectified spirit applied at first extracted two drams and a half, and water afterwards two drams and a scruple: The residuum in the first case weighed three drams, in the latter three drams ten grains.

XVI. WORMSEED. WORMSEED, *Semen lumbricorum, semen contra vermes*, so called from its use against worms, is a bitter seed, said by some to be the produce of China, by others of the Holy Land; whence its names *Semen sinæ* or *cinæ*, *Semen sanctum*, *Sementina*, *Santonicum*. The plant which affords it is not as yet known with any degree of certainty: By some it is referred to the genus of Wormwood, by others to that of Southernwood, and by others to that of Lavender Cotton. Tavernier relates, that he found the plant growing in fields in the province of Boutan; that the seeds when ripe, fall off upon the slightest touch, and are so light as to be blown away by the wind, and that they are gathered by applying baskets to the plant. As brought to us, they are commonly mixed with a notable quantity of small bits of stalks and leaves, which cannot be separated by winnowing, on account of the great lightness of the seed itself. Ettmuller supposes that the Wormseed of the shops is no other than the seeds of Tansy; but from those it is entirely different in its figure and appearance as well as in its smell and taste: The seeds both of Tansy and other plants, however, are not unfrequently mingled with it. Large quantities are imported immediately from Venice: I have there seen some of a fine green colour, which is held a mark of its freshness, though I have been assured, that the dealers have a method of impregnating the old decayed yellow seeds with the admired colour. Those commonly met with are of a yellowish-green colour, a bitter taste, and a very disagreeable smell.

Water extracts more from these seeds than rectified spirit; but the spirituous extract is far stronger than the watery, the former retaining the whole of the smell and taste of the seeds, whilst in the latter very little even of their taste is preserved. An ounce of the best Wormseed, digested in fresh parcels of rectified spirit, so long as it continued to give any tinge to the menstruum, yielded

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on inſpiſſating the tinctures, three drams thirty-three grains of reſinous extract; after which, it gave with water, five ſcruples and a half of a mucilaginous one. On treating another ounce firſt with water and then with ſpirit, I obtained four drams and a ſcruple of gummy extract, and only twenty-eight grains of Reſin. The reſiduum in the firſt caſe, weighed two drams thirty-eight grains; in the latter, two drams fifty-four grains. WORMSEED.

In diſtillation, rectified ſpirit brings over nothing. The diſtilled water taſtes and ſmells of the ſeeds, but ſcarcely exhibits a ſingle particle of Oil, though a whole pound be committed to diſtillation at once. The *Oleum cinæ* therefore, which has long been kept in the [German] ſhops, cannot be a genuine eſſential Oil diſtilled from Wormſeed.

XVII. CONTRAYERVA.

CONTRAYERVA is the root of a climbing ſpecies of Paſſion-flower, with leaves ſomewhat reſembling a horſe-ſhoe (*Clematis paſſionalis folio bifido Moriſon*) growing in the Spaniſh Weſt-Indies, particularly in Peru and Mexico.

The leaves of the plant are ſaid to be poiſonous, and to be employed by the Indians for poiſoning darts: The root is held an antidote to this and to other poiſons, and from this ſuppoſed virtue, the Spaniards give it the name of Contrayerva, that is, Counterpoiſon. The phyſicians of our own country expect from it no ſuch virtues; but they frequently exhibit it as a diaphoretic and alexipharmac in low fevers.

This root is about the thickneſs of the little finger, ſeldom more, thicker at one end than the other, very crooked, knotty, full of fibres, extremely firm and hard, almoſt of a horny texture, of a reddiſh-brown colour on the outſide, and ſomewhat whitiſh or greeniſh within, of a ſlight kind of aromatic ſmell, of an aſtringent taſte, not remarkably pungent, leaving a peculiar flavour in the mouth. Extracts made from it both by water and ſpirit are conſiderably pungent: The watery extract is the leaſt ſo, and hence may be uſed in ſome fevers where the ſpirituous tinctures or extracts would heat and ſtimulate too much. Neither the diſtilled waters nor the ſpirits have any remarkable impregnation from the Contrayerva.

An ounce of the powdered root yielded with water three drams and half a ſcruple of extract, and afterwards with ſpirit only ſeven grains: Rectified ſpirit, applied at firſt, took up five ſcruples and two grains from an ounce; after which, water extracted near a dram.

XVIII. SWALLOW-WORT.

WHEN Contrayerva is ſcarce, SWALLOW-WORT root is ſometimes uſed in its ſtead. Swallow-wort, *Vincetoxicum*, *aſclepias*, *hirundinaria* (*Aſclepias albo flore*, *C. B.*) grows wild in woods, and produces white flowers in July and Auguſt: It has a number of ſlender roots or fibres hanging from a ſomewhat larger one, of a not diſagreeable ſweetiſh taſte accompanied with a kind of bitteriſhneſs, and a ſlight pungency, when freſh of an unpleaſant ſmell, which is in good meaſure loſt in drying.

The juice of the freſh root changes the colour of blue paper to a reddiſh, and thus diſcovers a degree of acidity: When dry, it gives no mark of any acid, unleſs committed to diſtillation in an open fire, in which caſe, like other vegetable matters, it gives over an acid phlegm or ſpirit. Extracts made from this

SWALLOW-WORT.

this root both by water and vinous ſpirits have an agreeable ſweetiſh taſte. The watery extract is ſtronger in taſte than the ſpirituous; and even the watery extract made after the action of ſpirit is ſtronger than that made by ſpirit after the action of water; hence water appears to be the moſt proper menſtruum in regard to the quality as well as the quantity of the product.

From ſixteen ounces of the root I obtained by water five ounces, and from the remainder, by ſpirit one ounce. Another pound, treated firſt with ſpirit, gave only four ounces: From the remainder water extracted two; the indiſſoluble earthy matter amounting in both caſes to ten ounces or five eighths of the root. What ariſes in diſtillation, either with water or with ſpirit, is entirely inconſiderable.

XIX. VALERIAN.

VALERIAN root is ſometimes employed in the ſame intentions as the two foregoing, but its principal uſe is as an antiſpaſmodic: There are ſundry inſtances of epilepſies cured by the powder of this root given from a ſcruple to a dram and a half in white Wine, a laxative being premiſed. In the warmer parts of Europe, Italy, Spain, Portugal, *&c.* the garden Valerian (*Valeriana hortenſis, phu folio oluſatri dioſcoridis C. B. Valeriana odorata radice J. B.*) is chiefly made uſe of; but in our colder climate, this garden ſpecies proves far inferior in quality to the wild ſort, *Valeriana ſylveſtris major, C. B.*

The leaves of wild Valerian have a bitteriſh ſubſaline taſte, but no ſmell: Their juice changes blue paper conſiderably red, a mark that they contain an eſſential Salt of the acidulous kind. The root when largeſt, is about the thickneſs of the finger, but in general much thinner, of a browniſh-grey colour on the outſide and paler within, knotty, with numerous matted fibres, of a pungent, aromatic, bitteriſh, ſomewhat ſtyptic taſte, and a ſtrong diſagreeable ſmell, approaching to that of Indian Nard, and in ſome degree to that of Virginian Snakeroot, to which Valerian root has frequently been employed as a ſuccedaneum. The fibres are ſtronger in ſmell and taſte than the tuberous part of the root: A good deal of care is requiſite to waſh and clean them from the earth which ſticks among them.

An ounce of the dry root, thoroughly cleaned, cut and bruiſed, yielded with rectified ſpirit three drams and ſix grains of reſinous extract, and afterwards with water one dram and fourteen grains of a gummy one: Another ounce, treated firſt with water, gave four drams twenty-one grains, after which rectified ſpirit extracted only five grains: The indiſſoluble reſiduum weighed, in the firſt caſe three drams forty grains, in the latter three drams thirty grains. The diſtilled ſpirit is ſlightly, and the diſtilled water pretty ſtrongly impregnated with the ſmell of the Valerian, but no ſeparable Oil is obtained. The moſt active preparation is the ſpirituous extract, which is conſiderably more pungent and more bitter than the watery, and contains all the uſeful matter of the root concentrated into a ſmall volume.

The root of the ſmaller wild Valerian (*Valeriana paluſtris minor, C. B.*) is nearly ſimilar to the foregoing, but weaker. The principle in which its odour reſides, is more groſs and ponderous, no part of it being elevated in diſtillation by Spirit of Wine. The diſtilled water exhibits ſome appearance of oilyneſs. This root appears alſo to contain ſome portion of an Oil of the expreſſible kind,

whence the extract made by ſpirit after water proves unctuous and rancid. An extract made by water after ſpirit is in taſte ſaline: The ſpirituous extract made at firſt has an agreeable ſmell and an aromatic bitter taſte; the watery is in taſte weaker, and in ſmell offenſive. An ounce of the root yielded with water four drams and a half, and afterwards with rectified ſpirit ten grains: From another ounce I obtained, by applying ſpirit at firſt, two drams two ſcruples; and afterwards by water two drams and half a ſcruple: The reſiduum in the firſt caſe weighed three drams one ſcruple, in the latter ſomewhat leſs. An VALERIAN.

XX. PEONY.

THE roots and ſeeds of PEONY are reckoned alſo ſpecific antepileptics, but their virtues are perhaps rather imaginary than real. The red ſingle flowered Peony (*Pæonia folio nigricante ſplendido quæ mas*, *C. B.*) has been ſuppoſed to be the moſt efficacious, though at preſent the ſingle and double flowered ſorts are for the moſt part taken indiſcriminately.

Roots. The roots of Peony are pretty thick, tuberous, of a brown colour on the outſide and a pale reddiſh within: When freſh, they have a ſomewhat pungent ſweetiſh taſte, accompanied with a degree of bitterilhneſs. Hermann ſays they have no ſmell: They have a weak, but a very ſenſible one, not reſembling that of any other ſubſtance I know of.

An ounce of the dry roots yielded with water four drams and a ſcruple of gummy extract, and afterwards with rectified ſpirit only half a ſcruple of Reſin: The reſiduum weighed three drams and a half. Rectified ſpirit applied at firſt extracted, from an ounce, two drams and a half; from the remainder, water took up two drams, leaving as before, three drams and a half undiſſolved.

The ſpirituous extract is of all the preparations the ſtrongeſt both in taſte and ſmell: On firſt taſting, it diſcovers a remarkable ſweetneſs, which is followed by a diſagreeable bitterneſs, like that of the root in ſubſtance: The ſpirituous extract made after water has the ſame kind of taſte in a lower degree. The watery extracts have only a ſlight ſweetiſhneſs: Theſe are of a darker and browner colour than the ſpirituous. In diſtillation, rectified ſpirit brings over nothing: The diſtilled water ſmells and taſtes conſiderably of the Peony.

Flowers. The flower of Peony is large, like a Roſe: The fruit conſiſts of three, four, or five oblong horned pods, which open ſpontaneouſly when the ſeeds are ripe,

Seeds. The ſeeds are at firſt of a reddiſh colour, which deepens into a Garnet red, then changes to a violet, and at laſt to a bright gloſſy black: Under the coloured ſhell is contained a white kernel, which taſtes ſomewhat like peas.

An ounce of the huſked ſeeds, boiled with water, gave two drams of extract, of an oily ſmell and a ſweetiſh taſte: The remainder, treated with rectified ſpirit, gave half a dram of an inodorous bitteriſh extract: The indiſſoluble part weighed five drams and a half. On inverting the order of applying the menſtrua, I obtained by ſpirit five ſcruples from an ounce, and afterwards by water two ſcruples and a half, the reſiduum weighing as before five drams and a half: The ſpirituous extract appeared very unctuous or oily, taſted and ſmelt not diſagreeably, and ſeemed to be the moſt active preparation: The watery was both in ſmell and taſte very nauſeous, like rancid Oil. In diſtillation, ſpirit brings over nothing, and water exceeding little.

XXI. SCROPHULARIA. SCROPHULARIA, Figwort, (*Scrophularia nodosa fœtida, C. B.*) is so called from the supposed virtues of its root against scrophulous disorders. An ounce of the dry root, digested and boiled in several fresh parcels of water, yielded upon evaporating the decoctions, five drams and a half of extract; after which, rectified spirit extracted but five grains, two drams and a half remaining undissolved. On inverting the order of applying the respective menstrua, the spirituous extract weighed four drams, the watery one dram and a half, and the residuum as before, two and a half.

The extract made by applying water first, was in taste considerably sweet, and not disagreeable; the first spirituous extract was stronger and somewhat bitter: The watery extract made after spirit had no taste; the small quantity of resinous matter, which spirit extracted after the action of water, was quite disagreeable and somewhat rancid. The distilled water has very little taste or smell, the distilled spirit none.

XXII. POLYPODY. POLYPODY (*Polypodium vulgare, C. B.*) is a plant somewhat approaching in appearance to those of the Fern kind, growing upon old Oaks and other trees, as also upon old walls and rocks: It has no flowers; the seed is a fine dust lying on the back of the leaves. The roots are numerous, irregular, full of fibres and knots, supposed to resemble the feet of an insect, whence the name Polypody, *i. e.* Many-feet: They are externally of a brown colour, internally of a fine yellowish green, easy to break, of a sweet but somewhat nauseous taste, without any smell: Some of them discover a degree of acrimony and astringency.

An ounce of the root, freed from the fibres, yielded with rectified spirit three drams, and afterwards with water one dram of extract: Another ounce, treated first with water, gave three drams two scruples, and afterwards with spirit only one scruple; the indissoluble earthy part amounting in both cases to four drams, or half the weight of the root. The spirituous extract is manifestly oily; and on this oil, which is of the expressible and not of the essential kind, the nauseous taste of the Polypody seems to depend: The spirituous extract is extremely nauseous and rancid, the watery much more agreeable. In distillation, nothing considerable arises either with water or with spirit.

This root is sometimes given in obstructions of the breast and viscera, and supposed to be gently laxative, but it possesses that virtue in so low a degree, that two or three drams have scarcely any effect.

XXIII. DORONICUM. DORONICUM or Leopard's-bane, is another root of a sweet but unpleasant taste, accompanied with a bitterishness and astringency, and whose qualities are but little known. The plant, called by Caspar Bauhine *Doronicum radice dulci*, grows wild in stony grounds, in Italy, Austria, Switzerland, Languedoc and some other parts of Europe. The root comes chiefly from Italy, whence the name *Doronicum Romanum:* It is jointed, not very large, furnished with long fibres, of a yellowish colour on the outside and white within.

From

From two ounces of the dry root were obtained by water fourteen drams of extract, and afterwards by ſpirit five grains, only two drams remaining undiſſolved. The ſame quantity yielded, with ſpirit at firſt, four drams and a half, and afterwards with water nine drams, the reſiduum amounting to two and a half. The firſt ſpirituous extract is in taſte much ſtronger and ſweeter than the watery, though the watery contains alſo nearly all the active matter of the Doronicum. The diſtilled water has ſome little ſmell and taſte; the diſtilled ſpirit has neither. DORONICUM.

This root is by ſome accounted poiſonous, by others alexipharmac. It is moſt commonly ſuppoſed to be poiſonous only to quadrupeds; or if it is noxious to men when freſh, to be innocent when dry.

XXIV. IRIS.

THE roots of the common garden IRIS or Flower-de-luce (*Iris vulgaris violacea ſive purpurea ſylveſtris, C. B.*) are when freſh ſtrongly purgative: I have known unfavourable conſequences even from their external uſe as a coſmetic. By drying, they loſe their virulence, ſo as ſcarcely to purge at all.

Florence Orris.

THE dry roots of the Florence Iris or Orris (*Iris alba florentina, C. B.*) are entirely mild, and ſaid to be a medicine of good ſervice in diſorders of the breaſt. They have a pleaſant ſweet ſmell reſembling that of Violets, and hence are employed in ſweet-ſcented powders, for flavouring liquors, *&c.* The diſtilled water ſmells a little of the root, but exhibits no appearance of Oil: The diſtilled ſpirit alſo has ſome ſlight ſmell. The ſtrongeſt preparation both in ſmell and taſte, is the ſpirituous extract, this containing nearly all the active parts of the root concentrated into a ſmall volume. An ounce of the root yielded a dram and ſeventeen grains of ſpirituous, and afterwards a dram and forty grains of watery extract: Water applied at firſt extracted from the ſame quantity three drams, and ſpirit afterwards only eight grains. The extract made by water at firſt both taſtes and ſmells of the Orris, though not near ſo ſtrongly as the ſpirituous.

XXV. HYPERICUM.

THE flowers of ST. JOHN'S WORT (*Hypericum vulgare, C. B.*) abound with Reſin: They diſcover even to the touch an unctuous, reſinous, balſamic juice. An ounce yielded with rectified ſpirit juſt half an ounce of extract. They contain however ſo much mucilaginous matter, as to render nearly all the Reſin, or at leaſt all its active parts ſoluble in water: An ounce yielded five drams of watery extract, in taſte aſtringent and diſagreeable. Water applied after ſpirit, extracted two drams; ſpirit after water, only two ſcruples. The indiſſoluble earthy part weighed in the firſt caſe two drams, in the latter a ſcruple more. In diſtillation, nothing conſiderable ariſes either with water or ſpirit. It is obſervable, that the firſt tincture made in rectified ſpirit is of a fine red colour; but that when this is poured off, and the flowers digeſted in a freſh parcel of ſpirit, they tinge it greeniſh——Theſe flowers are ſuppoſed to be reſolvent, vulnerary, nervine: The ſuperſtition of former times aſcribed to them alſo extraordinary antidæmoniacal powers.

XXVI. GOLDILOCKS. THE flowers of the GOLDEN STÆCHAS or yellow Caſſidony (*Elichryſum ſeu Stæchas citrina anguſtifolia*, *C. B.*) are remarkable for preſerving their freſh yellow colour in long keeping: Some have a pleaſant muſky ſmell, others have none: Their taſte is pungent, aſtringent and bitteriſh. An ounce yielded three drams forty-four grains of watery, and afterwards fifteen grains of ſpirituous extract, half an ounce remaining undiſſolved. On inverting the order of applying the menſtrua, the ſpirituous extract weighed two drams forty-four grains, the watery one dram three grains, and the reſiduum four drams twelve grains. The extracts made firſt, either by water or ſpirit, are aſtringent; the ſpirituous is the ſtrongeſt. The diſtilled water has ſome ſlight flavour of the flowers, the ſpirit ſcarcely any.——Theſe flowers are uſed for ſtaining hair yellow, and medicinally as an aſtringent, anthelmintic, *&c.* They likewiſe give a yellow dye to wool.

XXVII. TEA. TEA is the leaf of an oriental ſhrub, called by Caſpar Bauhine *Chaa herba in Japonia*, by Breynius and Ray *Thé Sinenſium ſive t'sja Japonenſibus*, by Kæmpfer *Thea frutex*, &c. "the Tea-ſhrub, with leaves like thoſe of the Cherry-"tree, flowers like thoſe of the Dog-roſe, and a fruit compoſed of one, two, "and, for the moſt part, three berries." The plant comes the neareſt, in its general appearance, to the Dog-roſe, but is ſmaller, and without prickles. Dr. Cleyer, who lived ſome time in the Eaſt-Indies, ſent ſeveral ſpecimens to Simon Paulli in Denmark, and Dr. Mentzel in Berlin; of which figures may be ſeen in the *Acta Haffnienſia* and the German *Ephemerides*.

Only one ſpecies of the Tea-plant is as yet known; the differences in this commodity, as brought to us, proceeding from a difference in the climate, ſoil, age, method of collection and curation: Some indeed mention a ſingle and a double-flowered ſort, but of this we have no certainty. It is ſaid by ſome to be a native of China only, by others both of China and Japan: Others add a third country, Siam, and ſuppoſe, not without probability, that the Japonic name *Tſia* is derived from thence. Thus much is certain, that at preſent it is regularly cultivated in different provinces of Japan and China, but does not in all prove of equal goodneſs: Fiſien in Japan, and Nankin in China, produce the beſt.

The Chineſe plant whole fields with Tea; the Japaneſe only the borders of fields fronting the South. From ſix to a dozen of the berries are planted together (as they are very apt to fail) and covered with dung and earth: It is ſaid, that they are three years in coming up, and that they are carefully covered in the winter with ſtraw. After a certain number of years, which Kæmpfer limits between ſeven and ten, appear the admired leaves: After theſe have been gathered, the plant is either cut down, and new ſhoots expected from the root, or extirpated and renewed from ſeed. As the berries are extremely apt to ſpoil, inſomuch as to require being planted quite freſh in their native climate, and as the ſhrub does not bear being removed entire, there are little hopes of our being ever able to introduce it into Europe: Nor would it, probably, in theſe colder climates, prove equal in quality to the Chineſe, ſince even in China and Japan it proves greatly different in different provinces.

If

If the winter does not prove very ſevere, the leaves come forth in February, and about the end of this month, or the beginning of next, the firſt collection is made. Theſe early tender leaves are the true *Imperial*, called alſo improperly *bloom* Tea; but they cannot be the ſort to which the Dutch give that name, as being ſold upon the ſpot, to the princes of the country, for vaſtly more than the common Bloom-tea is ſold for in Europe. About the end of March or the beginning of April, the ſecond and moſt conſiderable crop is gathered: A large linen-cloth is ſtretched over the buſh, to defend from the ſun not only the gatherers, but the leaves themſelves, leſt they ſhould dry too faſt, and loſe their flavour. The leaves are picked one by one, ſo curiouſly, that the moſt induſtrious can ſcarcely collect four pounds in a day. They are commonly divided into four ſortments; of which the ſmaller upper ones are the beſt, the larger lower ones the worſt, and the intermediate of a middling goodneſs. The third collection is in the end of April or beginning of May: This likewiſe affords different ſorts, which are thoſe moſtly brought into Europe: The very beſt ſort which we meet with here, called Imperial Tea, is but the lower leaves of the ſecond crop. About the end of May, all the leaves on the plant are gathered promiſcuouſly, without ſorting, and ſold about the ſtreets to the poorer people; theſe being the worſt of all, and unfit for being cured in the Chineſe manner.

The Japaneſe, who ſwallow their Tea in ſubſtance along with its infuſion, dry it haſtily in iron pans over the fire, and grind it into powder. The Chineſe, on the other hand, are very curious of preſerving the leaves entire, and roll them up that they may be leſs apt to break in carriage. So ſoon as gathered, they are brought into an apartment furniſhed with a number of little furnaces, each of which is covered with a ſmooth iron plate. The leaves are ſpread upon the plates, and kept rolling with the hands, in one direction, till they become moderately dry, and begin to curl up about the edges, when they are immediately ſwept off upon tables covered with ſmooth cloſe mats, on which one perſon continues to roll them over and over, whilſt another fans them, that they may cool haſtily, and retain the curl. This proceſs is repeated two or three times or oftener, according as the leaves are diſpoſed to unbend upon ſtanding. If exſiccated without artificial heat, or by a very ſoft one, they rarely take the curl, and never hold it.

Meiſter relates, that the leaves are put into a hot kettle juſt emptied of boiling water; and that in this they are kept cloſely covered till cold, and then committed to the hot plates: According to Lemery, they are held in the ſteam of water. But Kæmpfer mentions nothing of all this; and if any ſuch thing is practiſed in regard to Green-tea, I ſhould imagine it to be only for ſoftening ſuch of the leaves as have happened to grow too dry, and would break in the curling. Boerhaave pretends that the preparers employ green Vitriol for improving the colour of the Tea: This I judge to be falſe, becauſe green Vitriol, inſtead of heightening the green colour of Tea, changes it to an inky blackneſs.

Thus much of the Green-tea. With regard to Bohea, I have not been able to meet with any ſatisfactory account, either in books, or from the communication of merchants; of both which, great numbers have been conſulted. Kæmp-

TEA. fer, and Dr. Cunningham, phyſician to the Engliſh ſettlement at Chuſan, affirm, that it is the leaves of the firſt collection; but this muſt certainly be a miſtake, as all the travellers agree that none of the firſt crop is brought into Europe, but that it is all reſerved for the princes of the land, and ſold at an immenſe price in China itſelf; whereas Bohea comes over in large quantity, and is cheaper than the ſecond and third crops, if not than the fourth alſo. Poſſibly a particular kind of Bohea is made from the firſt crop, for the uſe of the nobility; and our Bohea, prepared in imitation of that, from the third and fourth collections, or perhaps from the earlier growths alſo in thoſe provinces where the plant does not come to ſuch perfection as to afford a good Green-tea. The dark-browniſh colour, and Roſe flavour obſerved in this kind of tea, I hold, with Sigeſbeck, to be artificial: The method of curation deſcribed by Meiſter, which certainly is in general not practiſed for the Green, probably is for the Bohea, which receives, perhaps, in the kettle, both its tincture and its flavour. This at leaſt is certain, that by a ſimilar proceſs good Bohea may be made among ourſelves; a ſpecimen of which I have exhibited to a numerous audience. Some of the dealers in this commodity, in England, are not ignorant that certain European leaves, particularly thoſe of the Dog-roſe and Cherry-tree, may be ſo coloured and prepared, as to paſs for good Bohea. But I forbear to ſay any thing further of this manufacture, leſt a handle ſhould be given for new abuſes.

The Japan Tea has been obſerved to be of a clearer green colour than the Chineſe, and to have its leaves ſmaller; but which of the two is the beſt has not hitherto been determined, ſome preferring the one, and others the other: This controverſy does but little concern us, the Chineſe being the only one brought into Europe. In China, Tea is divided into a great number of different ſortments: There are ſixteen or twenty of the green leaves, from the difference in the collection only; and theſe are further multiplied, when the leaves are dry, by picking out ſuch as have miſcarried in the preparation. Among us, there are three principal kinds of green, and five of Bohea: From what province they are brought, of what crop they are the produce, and to which of the Chineſe ſorts they belong, is unknown: They have all names, but theſe are merely arbitrary, and ſerve only for the conveniency of the dealer. The beſt of the Green-teas is called Bing, Imperial and Bloom-tea, *Thea imperialis folio amplo laxo* of Dale: The ſecond beſt, *Hyſſon*, *Thea viridis optima folio oblongo Dal:* The third or worſt, *Singlo*, *Thea viridis folio minore Dal.* Of Bohea (*Thea fuſca folio ad nigredinem vergente*) the ſorts are, Ordinary, Pecco, Congo, Camho, and Souchong; of which the firſt is the worſt, and the laſt the beſt.

The Chineſe are extremely curious and cleanly in every branch of the Tea manufacture. They gather the leaves, as I have been well aſſured, with gloves made of a thin kind of leather. The workmen employed in the curation are reſtrained, for a fortnight before, from flatulent foods, and whatever might endanger communicating any ill flavour. The Tea, when cured, is packed up in large veſſels made of a mixture of Lead and Tin called Calin, or in wooden cheſts lined with this compoſition, or in canniſters of tinned plates ſoldered with the ſame, ſo tight, that they may be kept occaſionally under water.

As

TEA.

As ſoon as Tea became known in Europe, with its uſes among the Chineſe, all the European nations thirſted after it. Its great price at that time confined it to the rich, whence the learned were induced to examine the European plants, with a view to diſcover a cheap ſuccedaneum to it. The moſt celebrated of our ſubſtitutes is *Veronica*, on which Hoffmann and Joh. Francus have written particular diſſertations. The leaves of the red Whortle-berry and Roſe buſh are at preſent in greater eſteem, and come nearer to the taſte of the true Tea than any of the other plants that have been employed for this purpoſe, as Betony, Nettles, Agrimony, Coltsfoot, Eyebright, Strawberry, Scabious, Cowſlips, Golden-rod, Cherry-tree, Peach-tree, Wall-rue, ſharp leaved Plantane, Sanicle, Liverwort, Lungwort, Brankurſine, Balm, Sage, Roſemary, *&c.* I admit, with the recommenders of theſe plants, that they are poſſeſſed of conſiderable virtues, greater in particular caſes, than any that Tea can pretend to; yet ſtill they want the chief excellence of Tea, that of being a diluent almoſt univerſally acceptable.

Some pretended to have diſcovered the oriental Tea itſelf in Europe or America. The firſt of theſe was Simon Paulli, who obſtinately maintained that Tea was no other than the *Chamæleagnus* or Dutch Myrtle, but was refuted by ſeveral botaniſts in Europe, and by the ſpecimens ſent by Dr. Cleyer. The next was Father Labat, who in his voyages to America, relates, that in Martinico there grows a plant called wild Tea, agreeing in all reſpects with the China ſort, except that it has not ſo much of the Violet ſmell; "for in every "other reſpect, he ſays, it is aſſuredly the ſame thing." He adds further, that he had procured Tea-ſeeds from the Eaſt-Indies, and raiſed the plant in America. That he was miſtaken here (as he often was in botanic matters) is obvious from his own account: His ſeeds were ſmaller than Poppy ſeeds, whilſt thoſe of Tea are a kind of large nut or berry: His flowers had each but four ſtamina, whilſt in one of the Tea-flowers Kæmpfer counted two hundred and thirty. The plant is no other than that called in England Weſt-India Tea, *Lyſimachiæ purpureæ affinis Americana, procumbens, anonidis vernæ fruteſcentis folio ſingulari glabro* of Plukenet, found plentifully by Sir Hans Sloane about Spaniſh-Town in Jamaica. About twenty years ago there was another pretended diſcovery of Tea in the imperial dominions: But this like the others, when examined by a botaniſt, was found to be a quite different plant, the *Botrys ambroſioides mexicana* of Caſpar Bauhine. The jeſuits have at times made great noiſe with this plant, under the name of Roman Tea. I ſhall here add one more kind of Tea, uſed lately in France: When I was in Paris, about the year 1718, Tea and Coffee being common liquors, thoſe who affected diſtinction drank nothing but *Apalachine*, ſo called from the American territory of which it is the produce: It is the leaf of a tree ſomewhat reſembling the Almond, called by the natives *Caſſine*, by Hermann *Euonymo adfinis æthiopica, ſempervirens, fructu globoſo ſcabro, foliis ſalicis, rigidis, ſerratis.* We ſhall now drop the counterfeits, and return to the true Tea.

The Oriental Tea, as we have already ſeen, is of two kinds, Green and Bohea. The firſt is not only externally green, but likewiſe imparts the ſame colour to Water; the freſher the Tea, the greener is the infuſion; its prevailing

TEA. ing ſmell is generally that of violets or new hay: Bohea on the other hand is externally of a blackiſh brown colour, gives a browniſh tincture to Water, and ſmells of roſes. Green Tea ſhould be choſen freſh, of a fine colour, not inclining to a yellowiſh or browniſh, which are marks of too great age, well rolled, conſiſting of entire leaves, thoroughly dry ſo as to be friable betwixt the fingers, of a bitteriſh ſubaſtringent not ungrateful taſte, and a pleaſant light ſmell. When either the Violet or Hay-ſmell are very ſtrong, we may ſuſpect them to be introduced by art, the leaves having but little from nature: The firſt is communicated by putting into the caniſters a little Florence Orris-root; the latter, by placing the Tea for a few days, wrapt in papers, among new made Hay; this leaf being remarkably ſuſceptible of any kind of flavour. There are other abuſes common among the Dutch; as mixing, with the Tea, leaves of European growth and manufactue; and introducing into the old decayed Green, a freſh tincture.

The preparation and uſe of Tea as a dietetic liquor, are in general well known. With regard to its medical effects, ſome have exceſſively extolled, and others as extravagantly condemned it. The moſt virulent of its antagoniſts is Simon Paulli, who ſeizes every opportunity of expreſſing his diſlike to it: His royal Maſter, the King of Denmark, who had found great benefit from Tea, he vehemently diſſuaded from continuing its uſe, affirming it to be extremely unwholeſome; but all he gained from his Majeſty was this equivocal anſwer, *Credo* TE *non eſſe ſanum.*

Tea is in many caſes a very uſeful liquor; a grateful diluent in health, and a ſalutary drink in ſickneſs: It attenuates viſcid juices, promotes the natural excretions, excites appetite, and proves ſerviceable particularly in fevers, in immoderate ſleepineſs, after a debauch, and in head-achs ariſing from that cauſe: No other plant is known, whoſe infuſion paſſes off more freely by the emunctories of the body, or more ſpeedily excites the ſpirits. It is not however without its inconveniences: In habitual colics it is found to do harm, and in urinary obſtructions it ſhould be ſparingly drank: Its immoderate uſe is productive of cacochymic, cachectic, chlorotic diſorders, and weakens the tone of the ſtomach and nervous ſyſtem. It is ſaid, when new, to be narcotic, and to diſorder the ſenſes; but to loſe this quality, in great part by the exſiccation, and totally by being kept for a year: In the Tea countries, it is a principal caution to abſtain from it till this period, but in Europe there is no danger of its being uſed too new.

Some aſcribe the good or ill effects obſerved from the uſe of Tea wholly to the leaves, and others to the Water. The ſimple element has undoubtedly a conſiderable ſhare in both: It is not, as ſome have ſuppoſed, the virtue of the Tea-leaf, but the warm aqueous liquor, with the climate and diet, that preſerves the inhabitants of China and Japan from calculous and gouty diſorders——But on the other hand, that the herb communicates alſo ſome peculiar qualities to the liquor, is equally certain: In weak ſtomachs, a moderately ſtrong infuſion of Tea, without Sugar, generally provokes a puke: An infuſion of two or three drams of Bohea in two ounces of Water, is a common emetic among the Chineſe; and the Green is ſometimes employed in the like intention among ourſelves.

It

TEA.

It now remains to examine the phyſico-chemical ſtructure of Tea. Authors in general make a ſaline ſubſtance its prevailing principle: One ſtands up for a volatile, another for a fixed Salt; one for an alcaline, another for an acid, and another for an oily Salt; one will have it ſmooth, another pointed and rough; one nitrous, and another ſulphureous. But all theſe Salts are creatures of imagination, experiment diſcovering nothing of them. The experimental analyſis of Tea turned out as follows:

An ounce of fine Green Tea, digeſted with freſh parcels of Water, yielded four drams two ſcruples of gummy extract; and afterwards, with Spirit, only one ſcruple of reſinous extract; three drams remaining undiſſolved. On inverting the order of applying the reſpective menſtrua, an ounce gave four drams and a half of ſpirituous, and afterwards four ſcruples of watery extract; the reſiduum weighing three drams ten grains. The green colour reſides wholly, and the aſtringency chiefly, in the reſinous part; the reſinous extract, made by applying Spirit at firſt, being much ſtronger and more aſtringent, and at the ſame time more ungrateful, than the gummy extract prepared by applying Water at firſt. In diſtillation, pure Spirit brought over nothing from the Tea: Water elevated all its flavour.

An ounce of Bohea yielded with Water five drams of gummy, and afterwards with Spirit one ſcruple of reſinous extract; two drams and a half of indiſſoluble matter being left: Another ounce, treated firſt with Spirit, gave three drams and a ſcruple of reſinous, and afterwards five ſcruples of gummy extract; the reſiduum amounting to three drams. Though the watery tinctures of Bohea are different in colour from thoſe of the Green, the ſpirituous are nearly of the ſame green colour. The diſtilled Waters alſo are in flavour much alike, and the diſtilled Spirits equally void of flavour. But the firſt reſinous extract of Bohea is conſiderably leſs ungrateful than that of the other; and the Reſin extracted after Water, more ſo.

A ſpirituous extract made from either kind of Tea, poſſeſſes the whole of its taſte and ſmell: But in the watery extract, prepared in the common manner, all the fine flavour of the leaf is loſt. Nevertheleſs, if the inſpiſſation of the watery infuſion be performed without communication with the air, and in the gentle heat of a water-bath, the extract will turn out, next to the infuſion, one of the moſt elegant preparations. Such an extract, curiouſly prepared, may be of uſe to travellers; the bulk of a pea, diſſolved in Water, forming an extemporaneous Tea, without any apparatus. According to ſome, the Indians themſelves have a preparation of this kind, for making Tea upon a journey.

A ſolution of Vitriol of Iron dropt, in ſmall quantity, into an infuſion of Tea, changes its colour to a muddy Violet: A larger quantity turns it to an inky blackneſs; a proof that Tea poſſeſſes an aſtringent quality. On ſtanding for ſome time, a precipitate falls: It is pretty ſingular, that after the precipitation, the liquor appears greeniſh. Infuſions of Tea, like thoſe of other vegetables, are made deeper coloured by alcalies, particularly by thoſe of the fixed kind; and paler by acids, both of the mineral and vegetable kingdom.

XXVIII. COFFEE. COFFEE is originally the produce of Arabia, and was not known in Europe till the year 1650: It is now cultivated alſo in Perſia, in the Eaſt-Indies particularly the iſland Java, and in America. It is raiſed likewiſe in botanic gardens in different parts of Europe, but not without ſhelter and artificial heat: Prince Eugene's noble garden at Vienna produced Coffee more than ſufficient for his own conſumption.

The tree is uſually ſmall, though ſometimes it riſes to the height of twenty, thirty, and even forty feet: It is an evergreen, and at all ſeaſons of the year is found loaded with flowers and fruit. The flower is highly odoriferous, and reſembles that of the Jaſmine, of which the Coffee-tree is held a ſpecies: Juſſieu calls it *Jaſminum Arabicum lauri folio, cujus ſemen apud nos Cafè dicitur.* The Arabians name the tree *Bun* or *Bon*, whence perhaps the common expreſſion of Coffee *Beans:* The dietetic infuſion prepared from the ſeeds, they call *Cahoueh*, or *Coave*, whence *Coffee* or *Caffee.* The entire fruit ſomewhat reſembles a cherry: It contains, under a pulpy ſkin, an oval kernel, which ſeparates longitudinally into two parts, each covered with a thin ſhell and marked with a furrow on the flat ſide where they were joined. The ripe fruit is thoroughly dried in the ſun, and heavy wooden or ſtone rollers paſſed over it; by which the ſeeds are parted, and the ſkins or ſhells broken, ſo as to be ſeparated by winnowing.

Three ſorts of Coffee are diſtinguiſhed in trade; Arabian or Levant, Eaſt-Indian or Java, and Weſt-Indian or Surinam Coffee: The firſt is the ſmalleſt, and of a ſomewhat darker yellow colour than the other ſorts; the ſecond is the largeſt and of the paleſt yellow; the third, of a middling ſize, and in colour greeniſh. The green colour of this laſt may probably proceed from its coming over freſher than the others, or perhaps from its not attaining to ſuch a degree of maturity. All the ſorts are green in their unripe ſtate; and even thoſe, which by maturity or age have acquired the darkeſt yellow or browniſh colour, give a green tincture to water.

Two ounces of theſe ſeeds yielded with Water five drams, and afterwards with Spirit twenty-ſix grains of extract: On treating the ſame quantity firſt with Spirit and then with Water, the ſpirituous extract amounted to three drams and a half, and the watery to two drams: The indiſſoluble reſiduum weighed in both caſes ſomewhat more than ten drams and a half: In diſtillation, rectified Spirit brings over nothing, and Water nothing conſiderable. The ſpirituous extract is in taſte the ſtrongeſt, and not a little nauſeous: The watery is ſweetiſh and agreeable.

The peculiar flavour, for which Coffee is admired, is communicated by roaſting: Common Beans, Peas and other farinaceous ſubſtances, receive from that proceſs a ſimilar flavour, and have been ſometimes uſed as ſuccedanea to Coffee, and fraudulently mixed, by the venders of that commodity, with ſuch as is ſold in powder. Dillenius has given an expreſs diſſertation (in the *Ephem. Nat. Curioſo.*) on the ſubſtances which in ſmell and taſte reſemble Coffee; and finds that roaſted Rye and roaſted Almonds, come the neareſt to it.

COFFEE.

Sixteen

Sixteen ounces of Coffee were reduced by roasting to twelve ounces: The exhaling vapour, caught in proper vessels, condensed into a liquor weighing four ounces, chiefly aqueous, slightly impregnated with acid, and with a subtile Oil of an empyreumatic but agreeable smell like that of the roasted Coffee itself. COFFEE.

The flavour of the roasted seeds depends on a similar oily matter, so volatile as to be dissipated on keeping, but in too small quantity to be collected in its proper form by distillation either with Water or Spirit: The distilled Water tastes and smells considerably of the Coffee, the distilled Spirit much less.

Sixteen ounces of roasted Coffee yielded seven ounces two drams two scruples of watery, and afterwards five drams one scruple of spirituous extract: On inverting the procedure, I obtained from the same quantity, four ounces four scruples of spirituous, and four ounces of watery extract: The residuum in both cases was nearly in the same quantity, namely eight ounces or one half of the Coffee.

The spirituous extracts of Coffee are in taste nauseous: The watery, particularly that made by applying Water at first, are sufficiently agreeable, somewhat like that of Walnuts, with a pleasant bitterishness.

With regard to the medical qualities of Coffee, the common infusions or rather decoctions of it appear to be in general innocent; to be little disposed to produce the ill effects ascribed to them by some; and to have little claim to the extraordinary virtues for which they are recommended by others. Simon Paulli was the first who condemned the use of Coffee as well as Tea: But his prejudices against it are built on no better foundation than a ridiculous history related in Olearius's travels.

XXIX. VERONICA.

VERONICA or MALE SPEEDWELL (*Veronica mas supina & vulgatissima C. B.*) a small plant common in uncultivated places, is greatly recommended by Hoffmann and Joh. Francus as a substitute to Tea, and said to be of excellent service in disorders of the breast and many other diseases.

The leaves of Veronica have a bitterish somewhat astringent taste, with a very weak smell. An ounce of the leaves, picked and dried, yielded with Water five drams and a scruple, and afterwards with Spirit only nine grains of extract, the residuum weighing two drams thirty-five grains: On inverting the order of applying the menstrua, I obtained, from an ounce, three drams two scruples of spirituous, and a dram and a half of watery extract, the indissoluble residuum amounting to two drams forty-six grains.

The extract made by Spirit at first contains the green colour, and all the active matter of the herb; rectified Spirit extracting the whole of its taste and smell, and elevating nothing in its exhalation. The watery extract is weaker than the spirituous: The distilled Water smells and tastes a little, and but a little, of the Veronica: If the herb be previously fermented, we obtain by distillation a liquor strongly impregnated with its flavour.

Hoffmann reports, that Veronica, burnt to ashes, yields a larger quantity of fixed alcaline Salt than any other plant except Wormwood. I made the

VERONICA. experiment three different ways. Sixteen ounces of the leaves, distilled in a retort, left five ounces of a black coal, which by gentle burning in the open air, was reduced to one ounce of ashes: From this were obtained, by elixation with Water and inspissation, two drams and two scruples of Salt. Another pound of the leaves being burnt slowly with a smothering heat, the ashes weighed an ounce and a half, and the Salt two drams thirty-five grains, of which one dram and a half assumed a crystalline form. A third pound, burnt with a flaming fire, gave ten drams and a half of ashes, from which were obtained one dram of crystallised and four scruples of inspissated Salt. This plant therefore does not afford near so much Salt as has been reported, nor is the Salt purely alcaline, great, if not the greatest, part of it being, as Stahl has justly observed, marine Salt. The ashes, in the two first experiments, were ponderous, and of a yellowish white colour; in the last, they were light, spongy, and of a bluish white.

XXX. LUNGWORT, *Pulmonaria*, is a species of Moss (*Muscus pulmonarius C. B.*) LUNGWORT. growing upon trees, of a very irregular figure, concave and greenish on the side next the tree, convex and yellowish on the upper side, full of holes, thin, membranous, like leather or paper, internally of a whitish colour. It has been held a specific in disorders of the breast and lungs, as also in dysenteries, vomiting, *&c.* though the virtues ascribed to it do not appear to have any good foundation.

An ounce, digested in fresh parcels of rectified Spirit, gave five drams wanting half a scruple of resinous extract; and afterwards with Water only twelve grains of a gummy one: Another ounce, treated first with Water and then with Spirit, yielded three drams of gummy and two scruples of resinous extract: So that a considerably larger quantity of the two extracts is gained when Spirit than when Water is applied first.

I observed also, that the green colour resides in the resinous parts; that the spirituous extract is difficultly reduced to a due consistence; that the first spirituous extract is very apt to grow mouldy, contracting in a short time not only white hairy efflorescences, but likewise a yellow powdery matter; that the first extracts, whether made with Water, or with Spirit, retain in part the ill smell perceivable in the Lungwort itself; that in distillation, Spirit of Wine arises unchanged; and that the distilled Water has only a kind of ungrateful mustiness.

XXXI. PAREIRA BRAVA, *Butua*, *Cipo de cobra*, is the root of a velvet-PAREIRA BRAVA. leaved climbing plant, growing in the Brazils, called by Ray *Convolvulus Brazilianus*, *flore octopetalo*, *monococcus*. The root is pretty large, irregular, of a woody texture, composed of longitudinal fibres, which partly separate in drying, so as to leave manifest vacuities.

Mr. Geoffroy, in a short Memoir in the year 1710, makes two sorts of this root; one of a whitish colour on the outside and a Citron yellow within, the other brown without and browniish yellow within. I have been assured, that both are the roots of the same plant; that the young roots are externally somewhat whitish, and internally of a light Citron yellow; and that by age

they become paler within, and of a dark ſometimes blackiſh brown colour without. PAREIRA BRAVA.

This root is ſaid by Pomet to have been firſt introduced into France in the year 1688, by M. Amelot then embaſſador in Portugal. Helvetius brought it into great eſteem as a medicine, for diſſolving and promoting the expulſion of thick viſcid juices, in nephritic, icteric, hydropic and other diſorders. It has no ſmell unleſs warmed, in which circumſtance it ſmells ſomewhat like liquorice: To the taſte, it diſcovers as it were a ſweetneſs and bitterneſs blended together.

An ounce, cut in ſmall pieces, and digeſted in freſh parcels of rectified Spirit of Wine ſo long as it continued to give any tinge to the menſtruum, yielded, on inſpiſſating the tinctures, two drams three grains of reſinous extract, after which, Water extracted one dram, leaving five drams undiſſolved. On inverting the order of applying the reſpective menſtrua, the ſame quantity of the root yielded two drams one ſcruple of watery, and afterwards one dram ſix grains of ſpirituous extract: The indiſſoluble reſiduum weighed in this caſe but four drams and a half. The firſt ſpirituous extract is in taſte the ſtrongeſt of all the preparations: The firſt watery extract alſo contains nearly the whole of the active matter of the root, though it does not prove near ſo ſtrong as the ſpirituous: The extracts made by Spirit after Water, or by Water after Spirit, have very little taſte. Nothing ariſes in diſtillation either with Spirit or with Water.

XXXII. CHINA-ROOT.

CHINA, CINA, or SCHINA-ROOT is of two kinds, Oriental and Occidental. The two plants differ little or nothing in the leaves, flowers, or ſeeds, but conſiderably in the root, and remarkably in the time of flowering; the Chineſe blowing only in June and July, whilſt the American produces flowers ſucceſſively almoſt all the year. By ſome botaniſts they are referred to the genus of *Smilax aſpera*, by others to that of *Senecio*: The flower is compoſed of a number of floſculi, of a gold yellow colour; the leaves narrow and indented, like thoſe of Dandelion.

The root, when freſh, is fleſhy and full of juice; as brought to us, hard and woody: It is very irregular, and full of knots. The Oriental ſort, which is accounted the beſt, is commonly ſhorter, thicker, leſs crooked and leſs knotty than the American: It is alſo of a much paler reddiſh white colour on the inſide, the American being of a pretty deep reddiſh, nearly like that of Biſtort: The outſide is of a reddiſh brown, a full brown, or a blackiſh. The greateſt quantities are brought over by the Dutch Eaſt-India company, in bags of one hundred and twenty-five pounds: The merchants in Batavia give the Chineſe, for ſuch a bag, commonly four florins, ſometimes more, at the higheſt ten.

As this root is very ſubject to be preyed upon by worms, the induſtrious Dutch have contrived means for palliating that imperfection. I was once in a houſe at Amſterdam, where the manufacture of Aſafetida, Caranna, Caſtor, Muſk, and ſundry other drugs, was carried on. Among other ingenious operators, there were ſix perſons ſitting by a diſh, making old worm-eaten China-roots as fair and freſh coloured as any that ever came from China. They had a maſs compoſed of powdered China-root, Bole Armenic, and Gum Tragacanth,

CHINA-ROOT. canth, with probably ſome admixture of Litharge, for it was very heavy: This looked, when dry, exactly of the reddiſh-white colour of the internal part of the root. With this mixture they curiouſly filled all the holes they could come at, then penciled the root all over with ſome of the ſame maſs diluted, afterwards with another tincture, and laſtly rubbed it with Sope.

The beſt China-root is moderately compact and heavy; when broke, not mealy or duſty, but cloſe and of an oily or reſinous appearance. It has no ſmell, and ſcarcely any taſte, or only a ſlight kind of aſtringency. Two ounces yielded five ſcruples of ſpirituous extract, and afterwards four drams fourteen grains of watery extract: On inverting the order of applying the menſtrua, I obtained from the ſame quantity, five drams ten grains of watery, and afterwards only fourteen grains of ſpirituous extract.

Decoctions of this root drank freely, are ſaid to promote perſpiration and urine, and have been greatly commended in the venereal diſeaſe: They do not appear, however, to have any conſiderable virtue. If this root poſſeſſes any medicinal activity, the ſpirituous extract promiſes from its taſte, to be the beſt preparation.

XXXIII. SARSAPARILLA. SARSAPARILLA, Salſaparilla, Zarza, the root of another American *Smilax*, conſiſts of a number of long, ſmooth, flexible ſtrings hanging from one head, eaſily ſplit from end to end. There are different ſpecies of this plant, and the roots of ſeveral of them are met with in the ſhops. Monardus diſtinguiſhes three: One, brought from New Spain, of a whiter colour and ſlenderer than the reſt; another, from the province Honduras, of a darker aſh-grey colour, thicker, and better than the foregoing; and the third, from the neighbourhood of Guayaqui in the province of Quito (hence called *Sarſaparilla Guajaquillana*) of a darker colour than either of the others, inclining to black, thicker, longer, ſometimes of the length of a man. Three ſorts are at preſent alſo diſtinguiſhed in the ſhops; one which comes over in circular coils, another in ſhort, and the third in long bundles: The firſt is called Virginian or Engliſh, the ſecond Spaniſh, and the third Liſbon Sarſaparilla. The firſt is univerſally preferred, the others being ſubject to have decayed roots and different foreign matters in the middle of the bundle. It is rare to meet with Sarſaparilla that is truly good. The beſt is externally of a light brown colour, not greyiſh, or dark brown, much leſs of a blackiſh hue: Internally it is white, and in appearance as it were farinaceous, with a compact pith in the middle, not porous or ſpongy, much leſs powdery or duſty. It has no ſmell, and hardly any taſte, or only a juſt perceptible bitteriſh and ſomewhat mucilaginous one.

From ſixteen drams of the choiceſt roots were obtained ſix drams of watery, and afterwards only half a ſcruple of ſpirituous extract: Spirit applied at firſt to the ſame quantity of the root, extracted four drams, after which water took up two; the indiſſoluble earthy reſiduum weighed in the firſt caſe nine drams fifty grains, in the latter ten drams. Both the extracts made at firſt were bitteriſh, with this difference, that the ſpirituous was the moſt diſagreeable, and the watery ſomewhat ſaline: The ſecond extracts, or thoſe made by water after ſpirit,

ſpirit, and by ſpirit after water, had ſcarcely any taſte. Neither water or ſpirit brought over any thing conſiderable in diſtillation. SARSAPARILLA.

This root is ſaid to be remarkably ſerviceable in venereal and cancerous diſorders, and in impurities and viſcidities of the blood and juices in general. Some have given it in the form of powder, but it is more generally and more advantageouſly directed in decoctions. The watery decoction and extract ſeem to be the beſt preparations, though the ſpirituous alſo are not to be rejected——The colour of the tinctures is nearly the ſame with thoſe of Sopewort; the ſpirituous being of a yellowiſh red, and the watery of a reddiſh-brown.

SOPEWORT, *Saponaria* (*Saponaria major lævis*, *C. B.*) ſo called from the freſh leaves of the plant cleaning the hands like Sope, grows wild in woods and meadows, but is eaſily propagated in gardens: It loves a moiſt and ſomewhat ſandy ſoil: It rambles ſurprizingly with its roots, ſpreading in a little time to a vaſt compaſs, ſo as not to be eaſily extirpated. XXXIV. SOPEWORT.

The root is long and ſlender, with knots and fibres here and there, covered with a reddiſh-brown bark, under which lies a white tough ſubſtance, and in the middle a yellowiſh pith. This root has no manifeſt ſmell: Its taſte is ſweetiſh, accompanied with a light pungency. It has lately come into eſteem as a reſolvent and purifier of the blood, of great ſervice in venereal and ſcrophulous diſorders, ſimilar, but ſuperior to Sarſaparilla: Stahl was extremely fond of it.

On a chemical analyſis, by water and rectified ſpirit, two ounces of the root yielded eleven drams of watery, and only half a ſcruple of ſpirituous extract, the reſiduum weighing four drams two ſcruples and a half: Two other ounces, treated firſt with ſpirit and then with water, gave five drams of ſpirituous, and ſix drams of watery extract, the reſiduum amounting to five drams. All the active parts are taken up by the menſtruum applied at firſt, whether watery or ſpirituous; the extracts made by water after ſpirit, or by ſpirit after water, having ſcarcely any perceptible taſte.

Both the firſt extracts, on being chewed a little, cover the mouth and fauces with a pleaſant, ſoft, ſmooth, ſlippery ſubſtance, like frothy Saliva, accompanied with a ſlight warmth and pungency: The ſpirituous is ſweeter and ſtronger than the watery: The colour alſo of the ſpirituous tincture is a deeper reddiſh than that of the watery decoction. In diſtillation, ſpirit elevates nothing, and the diſtilled water has only a juſt ſenſible kind of ſweetiſhneſs.

THE roots of common BURDOCK (*Bardana*, *perſonata*, *lappa major*) are nearly ſimilar in quality to the foregoing: They have a ſlight ſweetiſh taſte without any ſmell, and are ſuppoſed to poſſeſs the ſame medicinal virtues. XXXV. BURDOCK.

This root is pretty long, an inch or more in thickneſs, externally of a yellow, a browniſh, and ſometimes of a dark brown colour, internally for the moſt part ſomewhat hollow, moderately compact and of a blackiſh-grey colour towards the ſurface, lined here and there with a white ſoft matter, and furniſhed with a white ſpongy pith in the middle.

Sixteen

BURDOCK. Sixteen drams of the dry root yielded with water ſeven drams fifty-two grains of extract, and afterwards with rectified ſpirit two ſcruples and a half; from the ſame quantity, treated firſt with ſpirit, I obtained five drams ten grains, after which water extracted three drams two ſcruples two grains: When ſpirit was uſed firſt, the indiſſoluble reſiduum weighed ſeven drams fourteen grains; when water, ſeven drams twenty-two grains. Water appears to be the beſt menſtruum, and the diſtilled liquor to be of no value.

It is affirmed in the *Ephemerides naturæ curioſorum*, that the leaves of this plant deflagrate in the fire like Nitre; and hence it is concluded, that Nitre, or a nitrous Salt, is one of its eſſential ingredients. We have formerly obſerved, that plants imbibe Nitre from nitrous ſoils: The Nitre in this experiment, was no other than that caſual impregnation. I have burnt the leaves of Burdock, and ſtrewed upon burning coals an eſſential Salt extracted from them, without obſerving the leaſt deflagration or mark of Nitre.

XXXVI. TURMERIC. TURMERIC, *Curcuma*, *Terra merita*, is the root of an oriental plant, called by Tournefort *Cannacorus radice crocea*, growing in Cananor, Calecut, Goa, Malabar, *&c.* There are two ſorts of this root, a long and a round: The firſt is the beſt, and hence is the only one commonly made uſe of. It ſhould be choſen large, freſh, compact, ponderous, not eaſy to break, of a fine yellow colour on the outſide, and a deep reddiſh-yellow within: It has a bitteriſh taſte, and ſmells ſomewhat like Ginger.

This root is uſed by the Indians as a ſpice: Medicinally, it has been ſometimes given as a reſolvent in cachectic, icteric, hypochondriacal, hyſterical and other diſorders; but its principal uſe is as a colouring drug, for dying cloth and ſtaining leather yellow, and in yellow varniſhes. It is obſervable, that fixed and volatile alcalies heighten its colour into a red, whilſt the nitrous and vitriolic acids weaken and incline it to a blackiſh-brown: If the root, however, be afterwards dried, its colour appears not to be greatly different from what it was at firſt.

It gives out its colour both to watery and ſpirituous menſtrua (*i*). Sixteen drams yielded with water five drams and one ſcruple of extract, and afterwards with

(*i*) *Turmeric---colour to water and ſpirit.*] It communicates to water its own deep yellow colour, but to rectified Spirit of Wine a red. The ſpirituous tincture, applied upon warm Marble, gives a durable red ſtain. Woollen-cloth, impregnated with a ſolution of Alum and Tartar, acquires on being boiled with the watery decoction, an elegant, but not very durable Orange yellow or Gold coloured dye. It is rarely made uſe of by the dyers on account of its price and the periſhableneſs of its colour.

There are ſeveral other colouring drugs which belong to this claſs: The principal are Fuſtick, Nephritic-wood, Log-wood, Brazil wood, and Madder.

FUSTICK.

FUSTICK is the wood of a ſpecies of Mulberry-tree, growing in Jamaica and Brazil, called by Sir Hans Sloane *Morus fructu viridi, ligno ſulphureo tinctorio.* It is of a deep Sulphur yellow colour, which it readily gives out both to water and to ſpirit. The watery decoction dyes prepared woollen of a very durable Orange yellow: The colour is imbibed by the cloth in a moderate warmth without boiling.

The *Fuſtet* or *Fuſtel* of the French is a yellow wood or root very different from our Fuſtick: It gives a fine Orange dye to woollen, but the colour is extremely periſhable

periſhable in the air. The plant grows wild in Italy and Provence, and is cultivated with us in gardens on account of the beauty of its flowers: It is called *Venice ſumach*, *Cotinus coriaria* or *Coccigria*; *Cotinus matthioli*, *C. B.*

NEPHRITIC-WOOD.

THIS wood is brought from the Eaſtern countries in large pieces, covered with a dark blackiſh bark. The wood is hard, heavy, compact, of a fine grain, of a whitiſh or pale yellow colour on the outſide, and a duſky reddiſh-brown in the heart. Of the tree we have no very certain account.

This wood, particularly the outer pale part, gives out both to water and to rectified ſpirit, a deep tincture, appearing when placed betwixt the eye and the light, of a golden colour, in other ſituations blue. Hence it is named by Caſpar Bauhine *Lignum peregrinum aquam cæruleam reddens*. By this mark it is eaſily diſtinguiſhed from pieces of a different kind of wood, which are ſometimes mixed with it, and which give only a yellow tincture to water.

It is remarkable, that the blue colour of the infuſion of Nephritic-wood is deſtroyed by acids, the liquor after the admixture of theſe, appearing in all ſituations yellow; and that the addition of alcalies, either of the fixed or volatile kind, in quantity ſufficient to neutralize the acid, reſtores the blueneſs. No other woody matter is known that gives any degree of blue tincture; and no other vegetable blue is known, that is thus deſtructible by acids.

This wood is at preſent rarely met with in the ſhops. Nor is it applied to any uſe, except that ſome have employed it medicinally, and expected from it diuretic virtues, whence its name *Nephritic-wood*.

LOGWOOD.

LOGWOOD or Campeachy wood (*Lignum brazilio ſimile, cæruleo tingens J. B.*) is the wood of a low prickly tree, which grows plentifully about Campeachy on the Bay of Honduras, and has of late been introduced into ſome of the warmer of the Britiſh plantations, particularly Jamaica: It is a native of low marſhy places. The wood comes over in pretty large logs, cleared from the bark: It is very hard, compact, heavy, and of a red colour. WOODS.

Logwood gives out its colour both to watery and ſpirituous menſtrua, but not readily to either: It requires to be raſped and ground into fine powder, and boiled in ſeveral freſh parcels of the liquors. Rectified ſpirit extracts the colour more eaſily, and from a larger proportion of the wood than water does.

The tinctures both in water and in ſpirit are of a fine red, with an admixture, particularly in the watery one, of a violet or purple. Volatile alcaline Salts or Spirits incline the colour more to purple: The vegetable and nitrous acids render it pale; the vitriolic and marine acids deepen it.

The watery decoction, wrote with on paper, loſes its redneſs in a few days, and becomes wholly violet. This colour it communicates alſo to woollen-cloth previouſly prepared by boiling with a ſolution of Alum and Tartar: The dye is beautiful, but very periſhable. It is often uſed by the dyers, as an ingredient in compound colours, for procuring certain ſhades which are not eaſily hit by other materials.

With Chalybeate ſolutions, it ſtrikes a black. Hence it is employed in conjunction with thoſe liquors, for ſtaining wood black for picture-frames, *&c.* and with the addition of Galls, for dying cloth and hats black: The black dyes, in which this wood is an ingredient, have a particular luſtre and ſoftneſs, far beyond thoſe made with Galls and Vitriol alone: The beauty, however, which it here imparts, is not permanent, any more than its own natural violet dye.

On the ſame principle, it improves alſo the luſtre and blackneſs of writing ink. Ink made with Vitriol and Galls, does not attain to its full blackneſs till after it has lain ſome time upon the paper: A due addition of Logwood renders it of a deep black as it flows from the pen, eſpecially when Vinegar or white Wine is uſed for the menſtruum.

Decoctions and extracts made from Logwood have an agreeable ſweetiſh taſte, followed by a ſlight aſtringency. They have lately been introduced into medicine, and given with ſucceſs in caſes where mild reſtringents are required. They often tinge the ſtools, and ſometimes the urine of a red colour.

WOODS.

BRAZIL.

BRAZIL is a red wood, brought from the province of that name in South-America. There are different ſorts of it, diſtinguiſhed by the names of Fernambouc, St. Martha, *&c.* What differences there are in the trees we know not: The woods, brought to us, differ little otherwiſe than as different parts of one log, ſome pieces being richer in colour than others.

This wood is called by Caſpar Bauhine baſtard Red-ſaunders, *Pſeudoſantalum rubrum ſive arbor Brazilia.* Many have confounded it with the true Red-ſaunders: The college of Bruſſels, in their account of that wood, have plainly miſtaken the Brazil for it. However the two trees may be allied in their botanic characters, the woods, chemically conſidered, are very obviouſly different; Brazil wood readily giving out its red colour to water, whilſt Saunders gives no red tinge to any aqueous liquor. The watery tincture of Brazil however, is not quite ſo deep as that made in rectified Spirit of Wine, or in volatile alcaline ſpirits.

The ſpirituous tincture ſtains warm Marble of a purpliſh red, which upon increaſing the heat, becomes violet. Mr. du Fay informs us, in a paper upon this ſubject in the French Memoirs, that if the ſtained Marble be covered with Wax and conſiderably heated, it changes through all the ſhades of brown, and fixes at laſt in a Chocolate colour.

The colour of the watery decoction is heightened by Alum, and inclined to a crimſon. A decoction made with Alum, in the proportion of about one part of the Salt to four of the wood, yields upon adding alcaline Ley or volatile ſpirits, a kind of crimſon lake verging a little to violet.

Solution of Tin in Aqua fortis, added to the decoction, throws down a much finer coloured Precipitate, little inferior in beauty to Carmine. This experiment, firſt communicated in the *Acta naturæ curioſorum*, I have ſeveral times repeated with ſucceſs. The quantity of lake is largeſt when Alum is uſed in making the decoction; but the colour is much the fineſt without it.

A tranſparent crimſon for water-colours is ſaid to be made by boiling the wood in ſmall Wort with a little Tartar. A large proportion of Tartar weakens the colour. All acids, if their quantity is conſiderable, have this effect: Thoſe of the mineral kingdom totally deſtroy it.

Brazil wood dyes woollen of a red colour, which does not want beauty, but has little durability. Mr. Hellot gives a pretty remarkably proceſs, by which both the beauty and permanency of the dye are improved. He directs the wood, cut in ſmall pieces, to be boiled in two freſh parcels of the hardeſt well-water that can be procured; the decoctions to be mixed together, and kept in a caſk, till they ferment, grow ſtale, and appear ropy like an unctuous Wine. The cloth is to be boiled for three hours with Alum and Tartar, in the proportion of ſix or eight ounces of the former, and two or leſs of the latter, to every pound, and afterwards kept moiſt, in a cool place, for eight or ten days, that it may be thoroughly penetrated by the Salts. A quantity of the ſtale decoction of Brazil is made to boil in a copper, and ſome common coarſe ſtuff, prepared as uſual with Alum and Tartar, dyed in it: Half as much more of the liquor is then added, and another piece of cloth dyed; ſo as that, between the two, about three fourths of the colour may be taken up. The cloth prepared as above is now to be dipt, and the liquor kept gently boiling, till it has taken the colour uniformly. The red, obtained by this proceſs, is a lively and durable demiſcarlet: On expoſure to the air for four months, in winter, it loſt nothing, but on the contrary became deeper, and ſeemed to gain a body.

The ſame author gives another method of fixing the colour of Brazil by aſtringents: The dyes thus produced are not red, but coffees and purple-cheſnuts very beautiful and gloſſy. For this purpoſe, he dilutes the ſtale decoction of Brazil with twice its quantity of water; and adds, for every pound of cloth, about an ounce of powdered Galls, and half an ounce of Gum Arabic. The cloth, prepared with Alum and Tartar, and kept moiſt for fifteen days, is boiled in this liquor for an hour or two, according as the colour is wanted lighter or deeper, and ſuffered to grow thoroughly cold before it is waſhed.

MAD-

MADDER.

MADDER (*Rubia tinctorum ſativa C. B.*) is one of the aſperifolious ſtellated plants, or of thoſe which have rough narrow leaves ſet in form of a ſtar at the joints of the ſtalks. The root, which is the only part made uſe of, is long, ſlender, of a red colour both on the outſide and within, excepting a whitiſh pith which runs along the middle.

This plant was formerly cultivated among us in quantity for the uſe of the dyers, who for ſome time paſt have been ſupplied from Holland and Zealand: Its culture is now again ſet on foot in this kingdom, under the laudable encouragement of a publick ſociety. We have formerly obſerved, that the colour of ſome exotic plants, as Alkanet, degenerates in our climate; but this is not the caſe with Madder, the Engliſh Madder being equal to the beſt that is brought from abroad.

Madder-root gives out its colour both to water and to rectified ſpirit: The watery tincture is of a dark dull red, the ſpirituous of a deep bright one. Taken internally (for it has ſometimes been uſed medicinally as an aperient and diuretic) it tinges the urine red. In the Philoſophical Tranſactions, and in the Memoirs of the French Academy, there are accounts of its producing a like effect upon the bones of animals, to whom it had been given with their food: All the bones, particularly the more ſolid ones, were changed both externally and internally to a deep red, but neither the cartilaginous or fleſhy parts ſuffered any alteration. Some of theſe bones, macerated in water for many weeks together, and afterwards ſteeped and boiled in Spirit of Wine, loſt nothing of their colour, nor communicated any tinge to the liquors.

The dealers in this commodity make three ſorts of it; Madder in the branch, Madder in the bunch or in the bundle, and Madder unbundled. Madder *in the branch* is the entire root dried: This, ground in mills into a groſs powder, is the *unbundled* Madder: The *bundled* or *bunch* Madder is a powder of the finer roots, freed from the outer bark and from the pith. It is ſaid that by keeping for two or three years, in cloſe caſks, the colour is improved; in open veſſels it decays.

Madder imparts to woollen-cloth, prepared with Alum and Tartar, a very durable, though not a very beautiful red dye. As it is the cheapeſt of all the red drugs that give a durable colour, it is the principal one commonly made uſe of for ordinary ſtuffs. Sometimes its dye is heightened by the addition of Brazil-wood; and ſometimes it is employed in conjunction with the dearer reds, as Cochineal, for demiſcarlets and demicrimſons. Mr. Hellot (from whoſe *Art de teindre* the remaining part of this note is extracted) informs us, that thoſe who dye the beſt Madder reds are particularly careful to keep the liquor of a heat conſiderably below boiling, increaſing the fire only towards the end, ſo as to make it boil for a minute or two juſt before the cloth is taken out, to confirm the dye. A boiling heat enables water to extract not only the red but a tawny or browniſh matter, which debaſes the red to a dull brick colour. MADDER.

The proportion of Madder is, about half the weight of the cloth. The beſt proportion of Salts for preparing the cloth to receive the dye, ſeems to be, five parts of Alum, and one of red Tartar, for ſixteen of the ſtuff; which is to be boiled with theſe for two hours or longer, then kept moiſt for ſome days, and afterwards digeſted with the Madder.

A variation in the proportion of the Salts varies the colour communicated by the Madder; and not only the ſhade but the ſpecies of colour. If the Alum be diminiſhed and the Tartar increaſed, the dye proves a red Cinnamon: If the Alum be entirely omitted, the red is deſtroyed, and a very durable tawny Cinnamon is produced.

On boiling the dyed cloth in weak alcaline Ley, great part of the colour is deſtroyed, and the remainder appears of a dirty or a kind of fallow hue: Solution of Sope, on the other hand, diſcharges a part, and leaves the remaining red more lively than before.

Volatile alcalies heighten the red colour of Madder, but at the ſame time render it fugitive like themſelves: Madder prepared with Lime and Urine, after the manner practiſed for Archil, loſt its red colour on attempting to dye with it, and communicated to the cloth only permanent nut colours.

If a pure red, as that of Cochineal, be applied

TURMERIC. with ſpirit only two ſcruples and a half, ten drams remaining undiſſolved. The ſame quantity, treated firſt with ſpirit, gave two drams and a half, and afterwards with water three drams and a half, ten drams of earthy matter remaining as before. In diſtillation, pure ſpirit brings over nothing: The diſtilled water ſmells of the Turmeric, and diſcovers ſome little drops of eſſential Oil.

CLASS IV.

UNCTUOUS VEGETABLES.

UNCTUOUS VEGETABLES. UNDER this diviſion are included thoſe vegetables which abound with a groſs, inodorous, inſipid Oil, ſeparable by expreſſion; as Almonds, the kernels of moſt fruits, and many kinds of ſeeds. An Oil of the ſame kind appears to be contained in all vegetable matters, though it cannot be ſeparated from all in its proper form: All vegetables yield an empyreumatic Oil on being diſtilled by a ſtrong fire; and this ſeems to be no other than the native Oil of the ſubject, rendered ſubtile, acrid and empyreumatic by the heat.

ALMONDS. THERE are two kinds of ALMONDS, ſweet and bitter; and ſome varieties of each of theſe, proceeding from the ſoil and climate. The tree which bears the common ſweet Almonds is called by Tournefort and Caſpar Bauhine *Amygdalus ſativa*; and that which produces the bitter, *Amygdalus amara*. They both reſemble the Peach-tree in the leaves and flowers, but grow to a much larger ſize: It is obſerved, that they do not well bear being tranſplanted. The greateſt quantities of Almonds are produced in Syria, Barbary, Turkey, Spain, Italy, the iſland Cyprus, and France. The German ſhops are ſupplied chiefly

applied on cloth which has been previouſly dyed blue, and afterwards prepared for receiving this red by boiling with Alum and Tartar, a purple or violet will be produced, according as the blue or the red prevail. The Madder red has not this effect; for as its colour is not a pure red, but is tarniſhed by the tawny matter which its woody fibres have in common with other roots; it gives upon blue only a cheſnut dye, more or leſs deep according to the deepneſs of the blue applied firſt.

There are, however, means of obtaining from Madder a fine purple, without the addition of any other colouring drug. A piece of white woollen-cloth, weighing half an ounce, was boiled for half an hour with ten grains of Roman Alum, and ſix grains of cryſtals of Tartar, and then taken out, ſqueezed, and ſuffered to cool. Twenty-four grains of bunch Madder were added to the ſame liquor; and after the Madder had given out its colour, twenty drops of a ſolution of Biſmuth (made in Spirit of Nitre diluted with equal its weight of water) were dropt in. The cloth was now dipt again, and in half an hour taken out, ſqueezed, and waſhed: It appeared of a crimſon colour, nearly as beautiful as if it had been dyed with Cochineal. To try the effect of loading it further with the colouring matter, it was returned into the liquor and boiled for a quarter of an hour longer: It had now acquired a purple colour ſufficiently vivid.

On varying this experiment, by keeping the cloth moiſt for ſome days after the preparation with Alum and Tartar, then dipping it in a plain decoction of Madder made as uſual without Salts; and adding, when it had gained a bright Cinnamon colour, the ſame ſolution of Biſmuth, the dye, inſtead of a purple, proved only a cheſnut.

chiefly from Provence and Valencia. In England, three ſorts of Almonds are diſtinguiſhed, ſmall Barbary Almonds, long Jordan Almonds, and ſhort, broad, Spaniſh or Valencia Almonds. ALMONDS.

Sweet Almonds conſiſt chiefly of expreſſible Oil and a fine farinaceous earth: The Oil is ſo plentiful, and ſo looſely intermixed with the other principles, that a part of it may be ſqueezed out with the fingers. The medical uſes of ſweet Almonds are, to ſoften and obtund acrimony, and to render reſinous ſubſtances ſoluble in water and in the animal fluids. The Reſins of Jalap, Scammony, and others, triturated with Almonds, diſſolve in water into an emulſion, and in this form operate effectually, without producing the violent gripes and other dangerous conſequences, which they never fail to do when given by themſelves. The Oil is an excellent medicine in cholicky and nephritic pains: Half an ounce may be taken for a doſe, with thirty drops of the mineral anodyne liquor. Sweet.

Bitter Almonds yield alſo an Oil to the preſs, not bitter like the Almonds themſelves, but as taſteleſs as that of the ſweet kind, all the bitter matter remaining in the cake left after the expreſſion. I have made ſundry experiments for determining in what principle the bitterneſs reſides; but they have not anſwered ſo perfectly as could be wiſhed. The Almond-cake was diſtilled both with pure water, and with water and Salt, and with highly rectified Spirit of Wine. The diſtilled waters were ſcarcely bitter, but ſmelt a little of the Almond, and had a conſiderable pungency: The diſtilled ſpirit diſcovered ſcarcely any pungency or bitterneſs, and differed very little in ſmell or taſte, from the pure ſpirit employed: Greateſt part of the bitterneſs, in all the diſtillations, was left behind, and continued in the inſpiſſated extracts (*k*). Bitter.

Bitter Almonds are poiſonous to animals that come into the world blind, particularly to birds. In the human body, they act as reſolvents and aperients. Sweetened with Sugar, or made into an emulſion, they are an uſeful diuretic, and an anthelmintic for children. If taken freely, they occaſion ſickneſs or vomiting.

THERE are ſundry other ſubſtances from which groſs Oils are commonly extracted in large quantity for mechanic uſes, and which it were needleſs to examine in particular, as they have no other remarkable qualities than thoſe

(*k*) *Bitter Almonds.*] Great part of the bitter matter diſſolves, by digeſtion, both in watery and in ſpirituous liquors; and a part ariſes with both in diſtillation. Spirit ſeems to diſſolve, and water to elevate moſt; but it did not appear that the whole is diſſolved or elevated by either, or by the alternate application of both. It is chiefly, if not ſolely, in the matter which ariſes in diſtillation, that the noxious qualities of the bitter Almonds reſide. A water diſtilled from them, when made of a certain degree of ſtrength, has been found from experiment to be poiſonous to brutes; and there are inſtances of cordial ſpirits flavoured with them being poiſonous to men. In theſe preparations the active principle has its activity probably increaſed, by its ſeparation from the ſoft inſipid Oil and the farinaceous matter with which it was combined in the kernel itſelf. The kernels of other fruits, that have any bitterneſs or particular flavour, appear to be impregnated with a ſubſtance ſimilar in quality to this poiſonous principle of bitter Almonds.

ALMONDS. those which depend upon the Oil, and as the principal differences of these kinds of Oils have been already mentioned. See p. 278, 322.

CLASS V.

Vegetables whose prevailing principle is an essential Oil.

OILY VEGETABLES. MANY of the substances of this class yield but a very small quantity of essential Oil: Nevertheless, in this Oil resides the whole of their distinguishing smell and taste. On distilling them with water, all the active parts of the subject arise, partly impregnating the liquor, and partly separating in their proper oily form: On inspissating the remaining decoction, a mucilaginous extract is left, which, if not altogether insipid, has at least nothing of the specific taste any more than of the smell or flavour of the original vegetable. Rectified Spirit of Wine frequently elevates little or nothing in distillation, the Oil remaining in the extract blended with the resinous parts: If this extract is boiled with water, the volatile Oil is dissipated as before, and only an insipid and inodorous resinous mass is left. To this class belong some of the flavourless pungent substances, as Horse-radish and Mustard-seed; some ungrateful pungents, as Garlic; some of the aromatic plants, as Rosemary and Anise; and some of the foreign spices, as Nutmegs.

I. HORSE-RADISH. HORSE-RADISH (*Raphanus rusticanus*, *armoracia*, the *Cochlearia folio cubitali* of Tournefort) is a root of common and well known use at table; but its chemical structure, the principle in which its pungency resides, and which so strongly affects the organs of taste and smell, have been hitherto wholly unknown.

The very soul of Horse-radish is an essential Oil, which is so ponderous as to sink in the aqueous fluid that comes over with it: A considerable part however is imbibed by the water, so as to communicate a strong impregnation: It is highly pungent, but not fiery or hot like most other essential Oils; as soon as the first impression of pungency is over, it leaves an agreeable sweetishness upon the tongue. It is on account of the avolation of this subtile Oil, along with the native watery moisture of the root, that Horse-radish loses its pungency in drying: The entire root may be preserved fresh in a cool place, especially if covered with sand, for a considerable time; but if the outer skin be taken off, the root sliced or shaved, and laid in a moderately warm place, its activity is quickly dissipated, and in this state it will not yield a single drop of Oil.

Eight ounces of the fresh root were reduced by drying to two ounces two scruples. Water extracts from this quantity one ounce of mucilaginous matter, and spirit takes up from the residuum fifteen grains of Resin. The essential Oil amounts to nearly the same proportion, besides what remains dissolved in the distilled water. Rectified spirit, applied at first, takes up seven drams from eight ounces, and water extracts afterwards near three drams. Both the extracts are somewhat sweetish, the spirituous most so. It has been said that the pungency of Horse-radish is covered by trituration with Almonds; but this did not answer upon trial.

GAR-

II. GARLIC.

GARLIC (*Allium ſativum C B.*) is a plant of the Leek kind, cultivated in gardens: It has long, flat, not tubulous leaves, and produces a ſpherical cluſter of hexapetalous Lily-like flowers, each of which is followed by a roundiſh ſeed veſſel. The only part made uſe of is the root; which conſiſts of a number of white, coated bulbs, incloſed in a purpliſh-red ſkin, with a buſh of fibres at the bottom: Such roots ſhould be choſen as are not very tough or compact.

Garlic has a ſtrong ſmell, and a ſharp biting taſte. In many places, it is employed in foods and ſauces: The Eaſtern nations are particularly fond of it. As a medicine, it is a powerful reſolvent and attenuant; and hence of good ſervice where the breaſt, ſtomach, or inteſtines, are obſtructed or overloaded with viſcid phlegm. Some have held it a ſpecific in the gout; and imagined, that it is the plentiful uſe of this root, which preſerves the Jews from that diſorder. Uſed as a ſuppoſitory, it occaſions a ſurprizing paleneſs and ſicklineſs of the face.

The ſmell of Garlic is to many people unſupportable. There are ſundry ſubſtances which have been ſaid to take off both its ſmell and taſte, as Cloves, Cinnamon, Calamus aromaticus, Cardamom-ſeeds, Zedoary and Rue. On trial, none of them was found to anſwer: They weaken or overpower the ſmell of the Garlic, more or leſs in proportion to their own quantity, but do not effectually conceal it. Zedoary and freſh Rue cover the ſmell more than any of the others, and the Rue ſomewhat more than the Zedoary. The ancients pretended that ſpiders had ſuch an averſion to the ſmell of Garlick, that if incloſed in a circle of the roots, they would be unable to get over it: This alſo I have tried, and found to be falſe. It is obſervable, that Arſenic and the Phoſphorus of Urine ſmell like Garlic: Wherever we perceive an alliaceous ſmell, if no plant of the Garlic kind be there, we may be ſure that it proceeds from an arſenical matter.

Many have imagined that Garlic abounds with volatile Salt, and that this is the cauſe of its ſtrong ſmell. Experiments have ſhewn, that the ſmell of Garlic reſides in a very different principle, and that the conſtituent parts of this root are the following. (1.) A large quantity of watery moiſture, amounting to nearly two thirds of its weight; for two ounces of the freſh root were reduced by drying to five drams two ſcruples. We cannot ſeparate ſo much liquid matter by expreſſion; four ounces of the freſh root yielded ſcarcely one ounce of juice: But nearly all that is loſt in drying may be collected by diſtillation. (2.) A conſiderable quantity of mucilaginous or gummy matter. Two ounces of the root being infuſed and boiled in water, in a glaſs body cloſely covered, and the water renewed ſo long as it continued to extract any thing from the root; the ſeveral infuſions, mixed and filtered, yielded on inſpiſſation, ſix drams and a ſcruple of gummy extract. (3.) A ſmaller proportion of unctuous reſinous matter. Two ounces, cut in pieces, and digeſted in freſh parcels of highly rectified Spirit of Wine, yielded on inſpiſſating the tinctures, only two drams and three grains of reſinous extract: This unctuous, tenacious, reſinous ſubſtance, diſcovers itſelf alſo during digeſtion, being very apt to precipitate and ſtick to the veſſel: To this are owing the precipitations which

juice

GARLIC. juice of Garlic occaſions in ſome metallic ſolutions, and which have been erroneouſly aſcribed to a ſaline principle. That the reſinous part is in leſs quantity than the gummy, appears further from hence; that rectified ſpirit, digeſted on the matter left by water, takes up only one ſcruple and ſeven grains; but water digeſted on the matter left by ſpirit, took up two drams, two ſcruples and two grains. (4.) An indiſſoluble earthy matter, amounting in either method of extraction, to two ſcruples and one or two grains upon two ounces. (5.) The fifth and principal ingredient, the very ſoul of the Garlic, is an eſſential Oil. In this alone reſides the ſmell, and the taſte, and all that diſtinguiſhes the Garlic.

The quantity of Oil is ſmall, but its activity and penetrancy are ſo much the greater: Its ſmell is abominably ſtrong. On diſtilling with water thirty-two ounces of the root, ſcarce half a dram of Oil could be collected: It is quite ropy and thick, and difficultly ſeparable from the aqueous fluid: The water diſtilled off in making the watery extract after ſpirit, diſcovered alſo a conſiderable ſmell, but of a fetid kind different from that of Garlic——A diſtilled ſpirit and ſaturated tincture are recommended by ſome as preſervatives againſt peſtilential infection. From the alexipharmac virtues attributed to this root, it has received the name of *Theriaca ruſticorum.*

III. ONIONS. THE common ONION (*Cepa vulgaris C. B.*) is another root, whoſe characteriſtic principle has been hitherto unknown. It is remarkable of the Oil of this root, that it remains all diſſolved in the diſtilled Water, which it impregnates with an exceſſively ſtrong ſmell: On diſtilling twelve pounds of Onions, peeled and cut in pieces, I could not ſeparate any Oil, though all the active parts of the root were collected in the Water.

This root contains a large quantity of aqueous moiſture: Eight ounces were reduced by drying to eight drams and a half. The matter diſſipated in the exſiccation was chiefly Water, with a little of the more ſubtile part of the Oil. The Onions, when about half dry, ſmelt like Rue.

An ounce of the dry root yielded with rectified Spirit ſix drams of extract, and afterwards with Water one dram eighteen grains: Another ounce, treated firſt with Water, gave ſix drams thirty-five grains, and afterwards with Spirit half a dram: The indiſſoluble reſiduum weighed in the firſt caſe two ſcruples ſixteen grains, in the latter eight grains more. The diſtilled Spirit is ſomewhat impregnated with the Oil of the Onion, diſcoverable rather by its taſte than by its ſmell; the more ſubtile odorous parts having been diſſipated in the previous exſiccation. The ſpirituous extract taſtes ſtrongly of the Onion: This is the ſtrongeſt preparation in point of taſte, and the diſtilled Water in ſmell——This root, beſides its culinary uſes, has been employed medicinally as a reſolvent and diuretic, in cachexies, dropſies, nephritic caſes, *&c.*

IV. MASTERWORT. THE roots of MASTERWORT, *Imperatoria, Aſtrantia, Oſtrutium,* (*Imperatoria major C. B.*) have a pungent, aromatic taſte, and a very ſtrong, agreeable ſmell: They are long, knotty, unequal, of a brown colour without and a yellowiſh-white within, full of greeniſh-yellow ſpecks, particularly towards the outſide, of a ſparkling manifeſtly reſinous appearance, and unctuous to the touch.

The distinguishing taste as well as smell of the root resides in an essential Oil, which is small in quantity but of great activity: Sixteen ounces scarcely afford more than half a dram. The distilled spirit smells a little of the root, but not near so strongly as the distilled water, pure spirit elevating only some of the more subtile parts of the Oil. The spirituous extract on the other hand is much stronger than the watery, the latter having lost in the evaporation all the Oil or specific matter of the Masterwort, of which greatest part is retained by the former. An extract made by spirit after water is a mere gross insipid Resin; and an extract made by water after spirit is merely mucilaginous. MASTERWORT.

An ounce of the root gave four drams ten grains of watery, and afterwards half a dram of spirituous extract: Rectified spirit applied at first extracted from the same quantity two drams and a half, and water afterwards five scruples: The indissoluble earthy part weighed in the first case three drams twenty grains, in the latter three drams fifty grains.

V. ANGELICA.

THE roots of ANGELICA are nearly similar in quality to those of Masterwort: They have a pungent, agreeable, bitterish taste, and a strong aromatic smell, somewhat of the musky kind. Their activity resides in an essential Oil and a resinous matter: The Oil is obtained by distillation with Water: On digesting or infusing the roots in Spirit of Wine or in Water, both the Oil and Resin are extracted, wholly by the former, and in part by the latter.

These roots, like those of most of the umbelliferous plants, are very apt to be preyed upon by Worms, to become carious, and fall into powder. So long as they are but merely worm-eaten, and not powdery, they are as fit for making the essential Oil, or the spirituous tincture and extract, as in their most perfect state; and even more so; the insects preying first, not upon the resinous and oily, but on the earthy and mucilaginous parts: When such roots are made use of, care must be taken to beat out, as much as possible, the worms and dust. The best method of preserving Angelica for any considerable length of time, is, to dry it thoroughly, then pack it up close in glass or other compact vessels; which are to be carefully stopt so as to prevent the admission of air, and kept in a dry place.

VI. ANISEED.

THE most active part of Angelica is the root; of ANISE, the seeds. Aniseed contains, besides its essential odorous Oil, a gross one of the expressible kind: The essential Oil, and the smell and taste of the seeds which depend upon it, are confined to the outer thin skin: The inner kernel, which is commonly divided longitudinally into two portions, has little or no smell, and exceeding little taste: In this resides the gross Oil, naturally inodorous, and insipid, but which, nevertheless, in its separation from the seed by the press, brings with it a part of the essential Oil, so as to become strongly impregnated with the peculiar flavour of the Aniseed: Its colour is greenish.

The essential Oil, though mild in taste, has an extremely strong smell, which it communicates to whatever it touches, in such a degree, as scarcely, or not at all to be overpowered. It coagulates in the cold, becoming thick like butter, a property observed in very few of the essential Oils: The coagulation is generally ascribed to its being distilled by a strong fire; but I have

ANISEED. drawn from Aniſeeds, by a bare digeſting warmth, an Oil which coagulated even in ſummer. The addition of a little common Salt is of ſervice in the diſtillation of the Oils of many vegetables: But for Oil of Aniſeed, that addition is by no means to be employed; this ſeed yielding only half as much Oil when diſtilled with Salt, as it does without. This Oil is drawn in large quantity about Magdeburg, and is in general greatly adulterated. We may ſometimes buy an ounce of the Oil for nearly the ſame price as a pound of the ſeeds; though a pound of the ſeeds yields only about half an ounce, and the reſiduum is of no uſe. It is remarkable of this Oil, that it diſſolves Sulphur in greater quantity than any other Oil, expreſſed or diſtilled: Digeſted with a compoſition of Sulphur and fixed alcaline Salt, it imbibes a large portion of Sulphur from the alcali, ſo as to acquire a thick conſiſtence, whilſt other diſtilled Oils take up very little, and expreſſed ones ſcarce any.

VII. STELLATED ANISE. AN exotic fruit, compoſed of ſeven or eight, and ſometimes nine capſules ſet in form of a ſtar, is diſtinguiſhed in the ſhops by the name of *Aniſum ſtellatum*, Stellated or STARRY-HEADED ANISE; its taſte and ſmell being exactly ſimilar to thoſe of the common Aniſeeds, but ſtronger. This fruit is called by ſome *Aniſum Indicum*, *Chinenſe*, *Ruſſicum*, *Moſcoviticum*, *Peregrinum*, *Philippinarum inſularum*, *Semen badian*, *Fæniculum ſinenſe*, *Cardamonum ſiberienſe*. Of the plant which produces it we have no account, except that Cluſius deſcribes and figures a ſmall branch received from the Philippine Iſlands with ſome of the fruits upon it: It is commonly ſuppoſed that this fruit, and the wood called in Holland from its ſmell Aniſe-wood, are taken from one tree.

The ſtarry capſules are ſomewhat broad at the end where they are joined, and pointed at the oppoſite one; externally hard, rugged, and unequal, and of a reddiſh brown colour like ruſt of Iron; internally ſmooth and gloſſy: They commonly open on the upper ſide, and diſcover an oblong kernel, about the ſize of Colocynth-ſeeds, covered with a ſmooth browniſh ſkin ſomewhat darker than that of Linſeed, internally yellowiſh and brittle. Herman relates, that the ſmell and taſte of this fruit is confined wholly to the outer capſules, the kernels having none. The ſkin of the kernel has indeed neither taſte nor ſmell, but the inner ſubſtance is in both reſpects ſtronger than the capſules; and in theſe particulars the ſtellated Aniſe differs remarkable from the common.

To determine this point more ſatisfactorily, I diſtilled equal quantities of the kernels and of the capſules, with equal quantities both of rectified Spirit of Wine and of Water: The diſtilled liquors were nearly equal in degree of ſmell and taſte, but in the diſtillation with Water, a good deal more Oil was obtained from the kernels than from the capſules; a ſure proof that the former is the moſt active part. The kernel contains alſo an expreſſible Oil, like the common Aniſeeds; but as this Oil is lodged in the ſame part, and naturally blended, with the eſſential, it proves, when ſeparated from the ſeed by expreſſion, very ſtrongly impregnated with its taſte and ſmell.

The ſtellated Aniſe is applicable to the ſame purpoſes as the common: It is uſed chiefly, in the form of tincture, and of a watery infuſion or tea, as an expectorant, carminative and ſtomachic.

SMALL-

VIII. SMALLAGE, *Apium*, *Apium paluſtre*, *Paludapium*, *Eleoſelinum*, is an umbelliferous plant, growing wild in marſhy places. The Garden-celery, of common uſe in food, is ſuppoſed to be no other than the wild Smallage improved by culture.

SMALLAGE

The moſt active part of Smallage appears to be the Seeds. Theſe, like moſt of the ſeeds of umbelliferous plants, contain two kinds of Oil, an eſſential one in which their diſtinguiſhing flavour reſides, and an expreſſible one of little ſmell or taſte: The firſt is lodged in the ſhell, the other in the kernel of the ſeed. Sixteen ounces of Smallage-ſeeds yield about two ſcruples and a half of eſſential Oil. One ounce of the ſeeds afforded, with Water, three drams two grains of gummy extract, and afterwards with rectified Spirit twenty-four grains of Reſin: Another ounce, treated firſt with Spirit, gave five ſcruples ſix grains of reſinous, and afterwards with Water two ſcruples ſeventeen grains of gummy extract. It is remarkable, that the reſinous extracts are of a fine green colour. Seeds,

Fifty-ſeven ounces of the freſh leaves of Smallage yielded on expreſſion thirty-four ounces of juice; from which were obtained, by a tedious cryſtallization, one dram and a few grains of a ſolid concrete ſlightly ſaline to the taſte, very difficultly ſoluble in Water, and which laid upon burning coals appeared more of the earthy than ſaline kind. Of the dry leaves, about one half is earthy or indiſſoluble: An ounce yielded with Water three drams forty-ſix grains of gummy extract, and afterwards with Spirit ſcarce half a dram of a reſinous one: Another ounce, treated firſt with Spirit, gave two drams two ſcruples and a half of reſinous, and afterwards one dram ſeventeen grains of gummy extract. In diſtilling a large quantity of the leaves with Water, a ſmall portion of eſſential Oil is obtained; but none could be collected on diſtilling an ounce. Leaves,

An ounce of the dried roots yielded half an ounce of watery, and afterwards half a dram of ſpirituous extract: Another ounce, on inverting the order of applying the menſtrua, gave a dram and a half of ſpirituous, and three drams of watery extract——With regard to the medical virtues of this plant, the roots are accounted aperient, and the ſeeds carminative. Roots.

CICUTA AQUATICA.

THERE is a poiſonous plant, greatly reſembling Smallage, growing in the ſame places, and which has too often been fatally miſtaken for it: The ſtalks, the flowers, the ſeeds, the roots, the juice, the ſmell and the taſte, are in both plants alike, and only the leaves different. The poiſonous herb appears to be but imperfectly known: The botaniſts themſelves have referred it to many different genuſes, ſome to that of *Apium*, ſome to *Anagallis*, others to *Phellandrium*, *Œnanthe*, *Myrrhis*, *Cicuta*, *Cicutaria*, *Petroſelinum*, *Aconitum*, *Sium*; Some give it the ſame name with Smallage, *Apium paluſtre*, or *aquaticum*. A certain phyſician of Regenſpurg, who ſome years ago opened a ſtudent that had been killed by it, calls it *Aconitum cæruleum petroſelinoide*, *odore Angelicæ*, *radice ireos ſimili*, *Caſp. Bauh. pin.* but unfortunately no ſuch name is to be met with in the writings of Caſpar Bauhine, or any other Botaniſt.

CICUTA AQUATICA. The poiſonous plant is the *Sium erucæ folio* of Caſpar and John Bauhine, *Sium alterum* of Dodonæus, the *Sium alterum oluſatri facie* of Lobel, who has given the moſt diſtinct figure, the *Sion aquaticum, rugoſis foliis trifidis, multifidis & dentatis* of Moriſon, the *Cicuta aquatica* of Geſner, the *Sium paluſtre alterum foliis ſerratis* of Tournefort, *Cicutaria* of Rivinus, *Sium majus alterum anguſtifolium* of Parkinſon, and *Sium majus anguſtifolium* of Tabernæmontanus. It is called in Saxony *Bartzen-kraut*, about Berlin *Berſte-kraut* (a name applied alſo to other poiſonous plants) in the Netherlands *Trœede Water-eppe*, in Italy *Gorgoleſtro*, in Spain *Rabacas*, and in England LONG-LEAVED WATER-HEMLOCK.

It differs from Smallage in the leaves being long, ſlender, and deeply cut, commonly into three ſegments: Thoſe of Smallage are cut in the ſame manner, but the ſegments are ſhort and broad. The roots of this plant are at firſt hollow and green, and lined internally with a ſhining white matter: By age they become harder and more ſolid, and change their green colour to a pale yellowiſh: When full grown, they are as large as the fiſt. They have a number of fibres, like the common Celery-root, eſpecially at the bottom, by which they are faſtened to the earth, at the bottom of the Water wherein they are commonly produced: They are often however looſened and carried off by the Water; and too often have been taken up and eaten for Celery, of which a melancholy inſtance happened in this neighbourhood [Berlin] ſome years ago: Their taſte and ſmell are the ſame, except that the ſmell is more penetrating, and that after the firſt agreeable taſte is over, ſomewhat biting is left upon the tongue.

Their poiſonous quality reſides in an orange-yellow juice, which is diſtributed indeed through the whole plant, but accumulated moſt plentifully in the roots. I took an old, yellowiſh, juicy root, and paring off the outer part which abounds moſt with juice, preſſed out ſome of the yellow liquor: A little of this, mixed with ſome portion of the root in ſubſtance cut ſmall, being given to a ſtrong young dog, he was in two minutes ſeized with violent convulſions: He then begun to vomit exceſſively, but was not relieved; in nine minutes he died. I know of no poiſon ſo active and ſo ſudden, excepting the ſubtile fumes which fly off from fermenting liquors, and the vapour of burning Charcoal confined: The moſt violent of the mineral poiſons, Arſenic and Corroſive Sublimate, are not equal to it. In a few minutes it brings on high convulſions, loſs of the ſenſes, raving, ſwelling of the eyes, inflammations, death: On diſſection, the ſtomach is ſometimes found corroded, the heart flaccid, blood extravaſated, the teſticles of a purple and blackiſh red colour: In others, there was ſcarcely any thing præternatural to be obſerved. See Wepfer's treatiſe *De Cicuta Aquatica*. The only means of preventing the terrible effects of this poiſon are, immediate vomiting, not by acrid medicines, but by taking large quantities of Milk, Oil, Fats, and if theſe fail, ſome Ipecacoanha or other mild emetic: Glyſters of Water, Milk, or Water-gruel, with Oil or butter, are alſo to be repeatedly injected; and gentle diaphoretics ſubjoined.

The young roots, as containing leſs of the yellow juice, are leſs dangerous than the old: The juice of a young green root being given to a dog, he ſoon fell down,

down, and appeared in great pain, but after vomiting ſeveral times, he grew better, and in a few days was well. By drying, the poiſonous quality is greatly abated, if not totally deſtroyed. CICUTA AQUATICA.

On a chemical analyſis, both the leaves and roots of this plant are found to contain a large quantity of watery moiſture. Four ounces of the freſh roots were reduced by drying to three drams and a half; from which were obtained two drams of ſpirituous and half a dram of watery extract; only one dram of earthy matter remaining from the whole four ounces. The leaves loſt more in drying, and yielded leſs earth than the roots: The quantity of watery extract was two drams from four ounces: The reſiduum gave but half a ſcruple to Spirit. Sixteen ounces of the leaves yielded in expreſſion ten ounces of juice; which, on being inſpiſſated, left no more than a ſcruple of ſolid matter.

IX. FENNEL; COMMON.

COMMON FENNEL SEED (*Fœniculum vulgare Germanicum C. B.*) is of a fine greeniſh colour, and an oval figure with ſeveral longitudinal furrows: Every ſeed parts longitudinally, when dry, into two. It has a ſtrong aromatic ſmell and taſte, ſomewhat like thoſe of a mixture of Aniſe and Dill-ſeeds with a little Angelica: To thoſe ſeeds alſo it is nearly ſimilar in medicinal virtue.

It contains a portion of expreſſible, as well as an eſſential Oil; the ſpecific qualities of the ſeed reſide in the latter, which has a ſtrong penetrating ſmell, but is not very ſubtile or volatile, for pure rectified Spirit of Wine carries up in diſtillation exceeding little of it. A conſiderable portion of oily matter ſeparates during the inſpiſſation of the ſpirituous tincture of the ſeeds; the Oil flowing at top, whilſt the more purely reſinous parts fall to the bottom.

On inſpiſſating a tincture drawn from two ounces of bruiſed Fennel-ſeeds, the pure reſinous extract amounted only to four ſcruples and four grains, and the Oil to two drams: Both the Oil and the Reſin were of a fine green colour. This extract ſmelt and taſted exceeding ſtrongly of the Fennel, little or nothing of its flavour having been diſſipated in the evaporation, and though a part was imbibed by the groſs Oil, yet much remained ſtill in the extract. The reſiduum of the ſeeds yielded with Water two drams of mucilaginous extract, leaving undiſſolved ten drams and a ſcruple of earthy matter.

The ſame quantity of the ſeeds, digeſted and boiled firſt with Water, gave four drams and a ſcruple of a mucilaginous extract; after which, rectified Spirit extracted one dram of Reſin; the reſiduum amounting, as before, to ten drams and a ſcruple. In diſtillation with Water, about a ſcruple of eſſential Oil was obtained from two ounces. The firſt watery extract had very little taſte: That made after Spirit was ſomewhat bitteriſh: The ſpirituous extract, made after Water, could not be reduced to a dry conſiſtence on acount of the groſs Oil that was blended with it: To the taſte it was diſagreeably oily.

The leaves of Fennel are nearly ſimilar in flavour to the ſeeds, but leſs grateful. They yield in diſtillation a ſmall quantity of eſſential Oil: That obtained from the upper leaves is remarkably finer, lighter, and more ſubtile than that of the lower: One ſwims on Water, whilſt the other ſinks.

The root is about the thickneſs of the finger, commonly ſtreight, of a whitiſh colour with a woody pith in the middle. It has a ſweetiſh aromatic taſte and ſmell, and is ſupoſed to poſſeſs an aperient virtue.

and SWEET. Sweet Fennel (*Fæniculum dulce C. B.*) is raiſed chiefly in Italy. The ſeeds are larger than thoſe of the common ſort, and of a ſweeter and more agreeable taſte: Their diſtilled Oil alſo is conſiderably more grateful. In other reſpects they agree nearly with thoſe of the foregoing ſort. The roots of this ſpecies are uſed by the Italians in food.

X. CHERVIL. CHERVIL (*Chærophyllum ſativum C. B.*) is a culinary herb, of a ſlightly aromatic taſte, and a not diſagreeable ſmell: It is ſaid to be diuretic, and of great ſervice in dropſies.

It contains a large quantity of watery moiſture: Sixteen ounces of the freſh leaves were reduced by drying to one ounce ſeven drams. Diſtilled with water, it gives over an eſſential Oil, ſmall in quantity, but poſſeſſing all the activity of the herb: From nine pounds I did not obtain quite half a dram; part was colourleſs and ſwum on the water; part was of a yellowiſh-brown colour and ſunk. I have gained alſo from ſundry other vegetables two kinds of Oil in one operation; a point which has not hitherto, that I know of, been conſidered, or indeed obſerved by any. It is commonly ſuppoſed, that only the Indian ſpices yield an Oil ſo heavy as to ſink in water.

The Oil of Chervil, even that which ſwims, is not very volatile, for rectified ſpirit brings over nothing of it: A conſiderable part of it, however, is diſſipated in drying along with the watery moiſture of the herb, and elevated in diſtillation by a phlegmatic ſpirit: Hence the ſpirituous extract made either from the freſh or dry leaves, has but little of the flavour of the Chervil; for when freſh leaves are uſed, their watery moiſture, rendering the ſpirit phlegmatic, enables it to carry up the Oil.

From an ounce of dry Chervil were obtained three drams and one ſcruple of watery, and afterwards three drams of ſpirituous extract. On inverting the order of applying the two menſtrua, I gained, from the ſame quantity, three drams ten grains of ſpirituous, and afterwards a dram and a half of watery extract.

The ſeeds of this plant diſcover no conſiderable taſte or ſmell, either in ſubſtance, in their diſtilled water or ſpirit, or in their extracts. An ounce gave a dram and a half of watery, and thirty-four grains of ſpirituous extract: Another ounce, treated contrariwiſe, gave only thirty-two grains of ſpirituous, and one dram thirty-three grains of watery extract.

XI. BETONY. BETONY (*Betonica purpurea C. B.*) has very little taſte or ſmell; but what it has, reſides in an eſſential Oil, as being elevated by water in diſtillation, though we can ſcarcely obtain any ſeparable Oil upon diſtilling a moderate quantity of the herb.

This Oil does not ariſe with rectified ſpirit, and hence the ſpirituous extract has a conſiderable taſte, whilſt the watery is almoſt inſipid. The ſpirituous extractions poſſeſs the green colour of the plant, whilſt the watery have nothing of it; and indeed vegetable greens in general ſeem to reſide in a reſinous matter,

ter, or at leaſt in a ſubſtance that is ſoluble in Spirit of Wine and not in water. BETONY.

An ounce of the dry leaves of Betony yielded with rectified ſpirit three drams two ſcruples, and afterwards with water two drams one ſcruple of extract: Another ounce, treated firſt with water gave five drams, and afterwards with ſpirit one; ſo that whichſoever of theſe menſtrua is firſt applied, ſix drams are extracted, and two drams left.

This plant has been celebrated for abundance of medicinal virtues, but does not promiſe to have any conſiderable activity: Its principal uſe is as an ingredient in herb ſnuffs, in compoſitions for ſmoking, and as a ſubſtitute to Tea. It is obſervable, that the roots of Betony differ greatly from the other parts of the plant; they operate both upwards and downwards, and ſeem to approach to the nature of the roots of Hellebore.

XII. DITTANY of CRETE.

DITTANY OF CRETE (*Origanum Creticum latifolium tomentoſum ſeu dictamnus Creticus Tourn.*) is a plant with ſmall woolly leaves, and monopetalous, labiated, purple flowers ſet in ſcaly ſpikes on the tops of the ſtalks. It grows wild in the iſland Crete or Candy, and is raiſed in gardens in ſome parts of Europe: The greateſt quantities are brought into Germany by the way of Venice, tied up in bundles, which are often mouldy or mixed with foreign matters in the inſide.

The leaves, when in perfection, yield a ſmall quantity of eſſential Oil, about half a dram at moſt upon ſixteen ounces, of a yellow colour, and an extremely ſtrong penetrating aromatic ſmell and taſte; it coagulates in the cold into the appearance of Camphor. Rectified Spirit of Wine elevates very little of the Oil, the diſtilled ſpirit having ſcarcely any ſmell or taſte. The ſpirituous extract is moderately warm and ſomewhat bitteriſh; the watery is in larger quantity, but of little taſte.

An ounce yielded with water two drams and a ſcruple of extract, and afterwards with ſpirit two ſcruples four grains: The ſame quantity, treated firſt with ſpirit, gave a dram and a half, and afterwards with water four ſcruples. The green colour of the leaves reſides in the Reſin: It is not indeed very diſtinguiſhable in the ſpirituous extract made at firſt, the gummy matter which the ſpirit takes up along with the Reſin diluting and covering it; but an extract made by ſpirit, after the gummy parts have been ſeparated by water is plainly green.

XIII. ROSEMARY.

ROSEMARY (*Roſmarinus hortenſis anguſtiore folio C. B.*) is a fragrant plant, of common uſe in perfumes, and in medicine as a corroborant of the nervous ſyſtem: Hungary-water is a vinous ſpirit impregnated by diſtillation with the flavour of the flowers.

The only active principle in this plant, is the eſſential Oil: The gummy extract, diveſted of the Oil, has no remarkable taſte any more than ſmell: The reſinous extract, as pure ſpirit elevates but a part of the Oil, retains a part, and not an inconſiderable one, of the flavour of the herb. In the form of an infuſion or tincture, its fragrance may be communicated both to water and to ſpirit.

The

ROSEMARY. The flowers of Roſemary are ſuppoſed to be more odoriferous, or at leaſt of a pleaſanter odour than the leaves; but ſtrictly ſpeaking, the flowers are inodorous. The coloured petala, carefully picked from the cups, have neither ſmell nor taſte: Such as diſcover any degree of theſe qualities have received them from the oily matter of the cups in gathering; the veſicles, in which the oily matter is lodged, being very eaſily burſt.

An ounce of the flowers, with the cups, yielded to rectified ſpirit ſeven ſcruples of extract, and afterwards to water two drams and a half: Water applied firſt took up from the ſame quantity four drams, and ſpirit afterwards one dram. Both the ſecond extracts had neither taſte nor ſmell: The firſt watery extract had very little of either; the firſt ſpirituous a notable ſhare of both together with the green colour of the flower cups. It is obſervable, that the ſecond ſpirituous extract appeared powdery, and not of a truly reſinous tenacity. The diſtilled water ſmelt and taſted conſiderably of the Roſemary, but from the quantity made uſe of in this experiment no actual Oil could be collected.

The leaves are richer in Oil: From forty-eight ounces I obtained three drams and half a ſcruple; a proportion ſmall indeed, but greater than the flowers have been known to yield. An ounce of the leaves afforded with ſpirit three drams of extract, and afterwards with water one dram five grains: On inverting the order of applying the menſtrua, the watery extract weighed three drams, and the ſpirituous one dram ten grains. The green colour of the leaves, as that of the flower cups, was retained in the ſpirituous extract.

Tournefort obſerves, that thoſe ſorts of Roſemary, which produce neither flowers nor ſeeds, and which have very hard ſhrubby ſtalks and long narrow leaves, ſmell ſtrongly like Camphor, and yield on diſtilling a large quantity for Oil, a portion of actual Camphor.

XIV. ORANGE FLOWERS. THE flowers of the ORANGE-TREE yield an highly odoriferous eſſential Oil, but in very ſmall quantity. This Oil is very ſubtile and volatile: It ariſes in diſtillation with rectified Spirit of Wine by the heat of a water-bath, and exhales in the air upon barely drying the flowers, leaving them nearly inſipid as well as inodorous. In ſeveral parts of Italy, expreſſed Oils are impregnated with the fragrance of theſe flowers for the purpoſes of a perfume. (See page 323.) The diſtilled water of Orange flowers is commonly called *Aqua naphæ*.

XV. SAFFRON. THE SAFFRON plant (*Crocus ſativus C. B.*) produces a purpliſh blue flower, whoſe ſtyle or piſtil is divided at top commonly into three fleſhy filaments of a deep orange red colour: In ſome plants there are ſix filaments, three pale and three deep coloured. The high coloured parts, carefully picked, dried on papers, and preſſed into cakes, are the Saffron of the ſhops; an aromatic of common uſe both for medicinal and culinary purpoſes, ſaid to be peculiarly exhilarating, antiſpaſmodic, ſerviceable in diſorders of the breaſt, *&c.*

There is no part of the world that produces better Saffron than England: The German writers who hold the Hungarian and Auſtrian to be the beſt, were probably unacquainted with the Engliſh, the exportation of it being prohibited.

hibited. The beſt Saffron is in long broad filaments, of a deep red colour, without any yellow parts, moderately dry, yet flexible and ſoft to the touch; difficultly pulverable; of a ſtrong and an agreeable ſmell, eſpecially at a diſtance; affecting the eyes, ſo as to draw tears from them, and of a pungent and ſomewhat bitteriſh taſte: It readily impregnates the hand with its ſmell, and ſtains the moiſt hand with a deep yellow colour. The Spaniards are ſaid to communicate the unctuoſity expected in it by actual Oil; and ſome, to increaſe its weight by the admixture of Carthamus flowers, and even of Litharge. SAFFRON.

It is obſervable, that water and ſpirit almoſt equally extract the virtue and colour of Saffron; and that water improves the ſmell and heightens the colour, whilſt ſpirit ſeems rather to weaken both. I dried two ounces and a half of the beſt Saffron, in the heat of a water-bath, and collected therefrom half an ounce of liquor of an exceeding ſtrong ſmell, but which had no appearance of any ſubſtantial Oil: It is this vapour of the Saffron which affects the head, and diſorders the ſenſes. The dried Saffron, which weighed juſt two ounces, was divided into two equal parts. I diſtilled rectified ſpirit from one ounce, and pure water from the other: The ſpirit had no perceptible ſmell or taſte of the Saffron: The diſtilled water ſmelt ſtrongly of it, though not ſo ſtrongly as that which exhaled in the drying. Nevertheleſs, upon inſpiſſating the liquors remaining after the two diſtillations to the conſiſtence of extracts, the watery extract was not only in larger quantity and of a deeper colour, but of a ſtronger ſmell than the ſpirituous; a plain proof of the power of ſpirit in covering or concealing the ſmell and colour, and of water in heightening or calling them forth. That the ſpirituous extract poſſeſſed theſe qualities in a greater degree than the watery, though it did not exert them, is evident from the circumſtances of the experiment, the Saffron in both caſes having loſt them: The following experiment is a further proof of this, and of the different powers of the two menſtrua. The ſpirituous extract, ſo pale and ſo inodorous, on being diſſolved in water (for either menſtruum diſſolves nearly all that the other has extracted) gives a deeper colour, and acquires a much ſtronger and more agreeable ſmell than the watery; and on the other hand the watery extract, diſſolved in rectified ſpirit, communicates but a pale tincture, and is hardly any longer to be ſmelt at all.

With regard to the quantity of extracts, an ounce of dried Saffron yielded with water ſix drams, and afterwards with ſpirit only one ſcruple, five ſcruples remaining undiſſolved. An ounce treated at firſt with ſpirit gave five drams and one ſcruple, and afterwards with water one dram half a ſcruple, the reſiduum weighing a dram and a half. The firſt ſpirituous extract, pulverized and digeſted in a ſuitable quantity of water, diſſolved entirely: The firſt watery extract, digeſted in ſpirit, left twenty-four grains of a colourleſs matter like ſand.

XVI. CARDAMOM.

THE LESSER CARDAMOM is the fruit of an Eaſt-Indian plant, called in the Hortus Malabaricus *Elettari*. It is a triangular membranous capſule, of a yellowiſh-white colour on the outſide and white within, containing about twelve or fourteen irregularly angular ſeeds lodged in three cells: Each ſeed is covered with a purpliſh or reddiſh-brown ſkin which eaſily comes off; the internal ſub-

CARDAMOM. ſtance is white: When the ſeeds are of a greeniſh colour on the outſide, and rattle upon ſhaking the capſule, the fruit has been gathered unripe.

Theſe ſeeds are an agreeable pungent aromatic: An ounce yields about a ſcruple of eſſential Oil, containing the whole of their pungency and ſmell, with fourteen or fifteen grains of reſinous, and forty-five grains of mucilaginous extract. The huſks are ſimilar in flavour to the ſeeds, but much weaker; no actual Oil can be collected from them, though the diſtilled water ſmells ſtrongly of the Cardamoms: They contain however more ſoluble matter than the ſeeds; an ounce yields above a dram of watery, and about twenty-five grains of ſpirituous extract.

There is a large and a middling ſort of Cardamoms, differing a little in appearance, and more conſiderably in their quality. The capſules of the large are of a triangular figure, and ſtand on ſeparate pedicles, like thoſe of the foregoing, but are commonly much darker in colour: The middling grow in cluſters, are paler coloured than the one and darker than the other, in figure round, with three ſeams or furrows at the junctures of the membrane which parts them internally. Both theſe are much weaker than the ſmall ſort: They nearly agree with it in regard to the quantity of watery and ſpirituous extracts, but ſcarcely afford any ſeparable Oil, particularly the large kind.

XVII. CINNAMON. CINNAMON is the bark of a tree of the Bay kind, growing in the iſland Ceylon, called by Hermann *Laurus zeylanicus baccis calyculatis.* Though the bark is one of the moſt grateful ſpices, the wood is inſipid and inodorous, and uſed only as firewood: The root is impregnated with aromatic matter, and yields in diſtillation not only an eſſential Oil, but a portion of Camphor. The bark is taken off twice a year, in the ſpring, before the tree begins to bloſſom, and in autumn, after the fruit has fallen: It is taken only from young trees, that of the old being woody and bitteriſh.

It has been obſerved that the thin membrane, which inveſts the internal ſurface of the bark, is vaſtly ſtronger in ſmell and taſte than the bark itſelf: Some ſuppoſe that the aromatic matter is originally confined wholly to this membrane, and thence communicated to the exterior parts in drying. Lemery is of opinion, that Cinnamon recives all its ſmell and taſte from the action of the ſun in its exſiccation: This can be no otherwiſe true, than as the active parts are more concentrated by the diſſipation of the watery: Hermann aſſures us, that it is not in the ſun but in the ſhade that the bark is dried.

Cinnamon has a very agreeable, pungent, ſomewhat aſtringent taſte, and a delightful ſmell: Greateſt part, if not all of it, is robbed of much of its better parts before it is brought to us. Its eſſential Oil is extremely pungent and fiery, but in ſmall quantity, ſixteen ounces of the very beſt Cinnamon ſcarcely yielding two ſcruples and a half. The diſtilled water appears milky, and retains in it greateſt part of the Oil, which on long ſtanding it depoſites to the bottom, and then becomes clear: Oftentimes, though ſeveral pounds of Cinnamon be committed to diſtillation, we ſhall ſcarcely be able to ſeparate any Oil till the water has been kept for ſome months. Mr. Stoll of Leipſick, pretends to have a method of collecting all the Oil from the water in a very little time; how juſtly I cannot determine: If this ſhould be found practicable, it would

would be a very uſeful diſcovery, provided the Oil received no injury. The Dutch, who are maſters of the Spice Iſlands, are the only perſons who prepare the Oil of Cinnamon in quantity; but it never comes from their hands unadulterated: We ſeldom meet with Oil of Cinnamon that holds leſs than half its weight either of expreſſed Oil or of Spirit of Wine. CINNAMON.

The Oil of this ſpice does not ariſe in diſtillation with rectified ſpirit: On diſtilling pure ſpirit from Cinnamon, it received no ſenſible impregnation; on drawing it over repeatedly from freſh parcels of the Spice, it ſmelt and taſted a little, but very weakly. An extract made by ſpirit contains the whole of the taſte and flavour of the Cinnamon: The watery extract has nothing valuable. Sixteen ounces yield two or more of ſpirituous extract, and about one and a half of watery.

CASIA LIGNEA agrees with Cinnamon in its ſmell, taſte, and chemical compoſition, and is the bark of a tree of the ſame kind. It differs however remarkably in the proportion of its principles, containing much leſs Oil, and a vaſtly larger quantity of mucilaginous matter. XVIII. CASIA LIGNEA.

THE NUTMEG tree, which grows moſt plentifully in the iſland Banda, is ranked by ſome among the nuciferous, and by others among the pruniferous trees; the fruit being a nut, with a conſiderable quantity of ſoft fleſhy matter on the outſide. Betwixt this pulpy ſubſtance and the ſhell, lies a purpliſh-red membrane, and within the ſhell is incloſed a kernel of a ſomewhat oval figure: The firſt is our Mace, the other Nutmeg. It is ſaid that the pulp has nothing of the flavour of the Mace or Nutmeg, and is unfit for eating; that the leaves of the tree ſmell ſtrongly of Nutmegs, but that the flowers have little ſmell. The candied Nutmegs brought from abroad are a preparation of the entire fruit, gathered unripe. XIX. NUTMEG.

Nutmegs are cured in the Indies by throwing a quantity of Quick-lime upon them in large tubs, filling up the veſſels with water, and after maceration for ſome hours, rinſing and drying the Nutmegs, which are then packed up for exportation in caſks fumigated with Sulphur: The fine powder which we ſee in the cracks and wrinkles of the Nutmeg is the remains of the Lime. This method of preparation, though apparently prejudicial, is ſaid to be found neceſſary, for deſtroying inſects or preventing their production: This laſt effect however, it does not conſtantly produce, for it is no uncommon thing to find wormeaten Nutmegs. The Nutmegs of only one kind of tree are uſually brought into Europe, though differing not only in ſize but in figure: Some of the nuts contain two kernels, which in this caſe are flatted on one ſide, and called Royal Nutmegs.

Some prefer thoſe which diſcover internally the greateſt quantity of white variegations, but thoſe which have the leaſt are really the beſt: It is in the reddiſh-brown matter, and not in the white, that the Oil and aromatic virtue reſide, the white having ſcarcely any taſte or ſmell. It is only this inactive white part that worms prey upon; and hence a Nutmeg is not much the worſe for being wormeaten. It is amuſing to examine a wormeaten Nutmeg, that has had abundance of white veins: It looks a curious little labyrinth.

NUTMEG. This fruit contains two kinds of Oil, a groſs ſebaceous, and a volatile eſſential fluid one, in which laſt the taſte and ſmell of the Nutmegs wholly reſide. The eſſential Oil appears alſo to be of two kinds, one light and ſubtile, ſo as to ſwim upon water, and ariſe in diſtillation along with rectified Spirit of Wine; the other groſſer and more ponderous, ſo as to ſink in water, ariſe difficultly in diſtillation with water itſelf, and not at all with ſpirit.

From ſixteen ounces of Nutmegs I obtained half an ounce of eſſential Oil, and from four and a half to five ounces of inſipid ſebaceous Oil: This laſt remains behind after the diſtillation of the other, and in part ſwims like tallow upon the ſurface of the water: The decoction inſpiſſated leaves a mere mucilaginous maſs, of no remarkable taſte or ſmell. Rectified Spirit of Wine diſſolves all the eſſential Oil and a part of the expreſſible; and on being again abſtracted or evaporated, leaves in the extract almoſt all that it had taken up from the ſpice.

Four ounces of Nutmegs yielded with ſpirit one ounce of oily extract, and afterwards with water half an ounce and two ſcruples of a gummy one, together with five drams and one ſcruple of expreſſible Oil as inſipid and inodorous as the Gum. The ſame quantity treated firſt with water, gave ten drams of gummy extract, with two ſcruples and a half of groſs Oil which aroſe to the ſurface during the abſtraction of the liquor, and half a ſcruple of eſſential Oil which ſunk to the bottom of the diſtilled water: The remainder, treated with ſpirit, gave five drams more of groſs Oil, and two drams of an unctuous oily extract. The earthy matter amounted in both caſes to two ounces, or half the original weight of the Nutmegs. On committing four ounces of Nutmegs, pounded and warmed, to a warm preſs, I obtained nine drams of Oil: From the reſiduum were gained an ounce of gummy extract, a pretty ſtrong taſted water, four ſcruples of oily extract with ſpirit, and a dram of inſipid Oil: The earthy matter weighed here but eleven drams.

The groſs Oil of Nutmegs brings forth with it, in expreſſion, a conſiderable portion of the eſſential Oil, and hence is impregnated with the flavour of the Spice. This Oil, or rather ſebaceous matter (for it is quite conſiſtent) is prepared in quantity in the Eaſt-Indies, and brought over ſometimes in cakes, but chiefly in ſquare maſſes like Sope, of a reddiſh-yellow colour, reſembling that of Mace: It is vulgarly called Oil of Mace. Sixteen ounces of this concrete contain five drams and a half of the eſſential Oil of the Nutmeg, which totally ſinks in water, and of which no part ariſes in diſtillation with Spirit of Wine; the more ſubtile Oil having probably been diſſipated in heating or roaſting the Nutmegs previouſly to the expreſſion. The fluid expreſſible Oil in the above quantity amounts to ſix ounces two drams and a half; and the ſolid ſebaceous ſubſtance, which gives conſiſtence to the two foregoing, to nine ounces and a half. This laſt, when ſeparated from the others, is perfectly inſipid and inodorous, and of a chalky whiteneſs; hence it is an excellent baſis for odoriferous balſams: We may impregnate it with any flavour by the addition of ſuitable eſſential Oils, and tinge it of any colour by coloured powders: It melts in a gentle heat like Tallow.

MACE

MACE, one of the exterior coverings of the Nutmeg, is at firſt of a purpliſh-red colour, which changes, before it arrives among us, to an orange yellow, and by long keeping grows paler and paler. Mace is a warm aromatic, like the Nutmeg, accompanied with a degree of bitteriſhneſs; and like that Spice alſo contains both an eſſential and expreſſible Oil. XX. MACE.

Sixteen ounces of Mace yielded with rectified ſpirit four ounces and a half of extract, which retained ſome of the expreſſible and the more ponderous part of the eſſential Oil, the lighter ariſing towards the end of the inſpiſſation, and impregnating the diſtilled ſpirit: From the reſiduum were obtained two ounces and a half of gummy extract, eight ounces and ſix drams remaining undiſſolved. The ſame quantity, treated with water firſt, gave four ounces of gummy extract, with five drams of eſſential Oil, which aroſe during the inſpiſſation, and ſunk to the bottom of the diſtilled water: The reſiduum gave with rectified ſpirit three ounces of an oily extract, eight ounces and a half remaining undiſſolved. The watery extract has an unpleaſant ſomewhat ſaline taſte, which that of Nutmegs has nothing of. On expreſſion, Mace yields an Oil leſs conſiſtent than that of Nutmegs, and which is uſually brought from the Eaſt-Indies in glaſs or porcelane veſſels.

CLASS VI.

Vegetables whoſe qualities depend partly upon an eſſential Oil, and partly on a gummy-reſinous matter.

THE ſubſtances of this claſs agree with thoſe of the foregoing in containing an eſſential Oil, ſometimes in large and ſometimes in ſmall quantity. They differ in containing other active matters joined to the Oil. There, the Oil and diſtilled water poſſeſs the whole of the ſpecific taſte and ſmell of the ſubject: Here, they poſſeſs but a part, the decoction left after the diſtillation, retaining a conſiderable ſhare of that peculiar taſte by which the original vegetable was diſtinguiſhed. Thus the Carline-thiſtle, Camomile, Wormwood, Orange-peel, *&c.* leave all their bitterneſs in the decoction, whilſt all their ſmell and flavour diſtil: And ſome of the ſpices, as Cloves and Pepper, leave in like manner greateſt part of their pungency behind. OILY-GUM. RESINOUS.

THE CARLINE-THISTLE (*Carlina acaulos magno flore albo C. B.*) is a very prickly ſort of Thiſtle, without any ſtalk, growing in mountainous countries, particularly in the mountains of Switzerland. The roots are brought to us tied in bundles, chiefly from Thuringia. They are ſix or eight inches in length, about the thickneſs of the little finger, of a brown colour on the outſide and whitiſh within; of a ſtrong not agreeable ſmell, and a bitter pungent taſte. They are ſometimes uſed as diaphoretics and alexipharmacs, but chiefly in the diſorders of cattle. I. CARLINE.

Sixteen ounces of this root yield about two ſcruples and a half of eſſential Oil: This contains the ſmell and all the ſpecific taſte of the root, as the Reſin does its bitterneſs. It is difficult to obtain the Oil and the Reſin perfectly pure from

CARLINE. from one another. A tincture made in rectified ſpirit, leaves, on being inſpiſſated to an extract, almoſt all the Oil, along with the Reſin, and a portion of the gummy matter, the diſtilled ſpirit having ſcarcely any ſmell or taſte. And on the other hand, in diſtilling the Oil with water, ſome of the more ſubtile parts of the Reſin conſtantly ariſe with it, rendering the Oil thick and ropy, or diſpoſed to become ſo upon ſtanding for a little time, and ſo ponderous as to ſink in water: On rectifying the Oil, or diſtilling it a ſecond time with a gentle heat, it ariſes fluid and thin, and floats on the ſurface of the water, leaving behind a conſiderable quantity of groſs reſinous matter.

Two ounces of the root, cut in ſmall pieces, yielded with rectified ſpirit two drams thirty-eight grains of reſinous extract, ſufficiently ſtrong both in ſmell and taſte, and poſſeſſing nearly all the active parts of the Carline: From the reſiduum were obtained, by water, ſix drams two ſcruples of mucilaginous extract, in taſte ſlightly bitteriſh and ſomewhat ſaline. On inverting the order of applying the reſpective menſtrua, the watery extract amounted to an ounce and half a dram, and the ſpirituous only to forty-five grains. The watery extract made at firſt was much ſtronger than that made after the action of ſpirit, but far weaker than that made by ſpirit at firſt.

II. NIGELLA. THE ſeeds of FENNEL-FLOWER, *Nigella*, *Melanthium*, *Gith*, (*Nigella flore minore ſimplici candido C. B.*) are of an irregularly angular figure, a black colour on the outſide and greyiſh within, of a pungent aromatic and ſomewhat oily ſmell and taſte. We often find among them ſome yellow ones, which are ſuppoſed to be unripe.

Theſe ſeeds contain only a ſmall quantity of volatile eſſential Oil, but a larger of a groſs expreſſible one, ſeparable not only by actual expreſſion, but by extraction with Spirit of Wine, the Oil diſſolving in the ſpirit along with the reſinous matter, and afterwards parting from it in the evaporation: A groſs Oil may be collected in this proceſs, whether the gummy matter has been previouſly ſeparated by water or not, with only this difference, that the Oil obtained after the action of water becomes ſooner rancid than the other.

Two ounces of the ſeeds yielded with rectified ſpirit three drams of extract, and afterwards with water three ſcruples and a half: Water applied at firſt extracted juſt as much as ſpirit did; but ſpirit after water took up leſs by a ſcruple and a half than water after ſpirit. The quantity of Oil which ſeparated in the ſpirituous extraction, was four ſcruples. The diſtilled ſpirit ſmelt and taſted conſiderably of the ſeeds: The ſpirituous extract was nevertheleſs ſtronger than the watery——Theſe ſeeds are recommended in catarrhs, vertigos, quartans, *&c.* and as an errhine.

III. BIRTHWORT. BIRTHWORT, *Ariſtolochia*, ſo called from the medical virtues aſcribed to it, is a plant with an irregular, tubulous, monopetalous flower. Three ſorts are mentioned by pharmaceutic writers: *Ariſtolochia rotunda flore ex purpura nigro C. B.* round-rooted Birthwort; *Ariſtolochia longa vera C. B.* long-rooted Birthwort; and *Ariſtolochia clematitis recta C. B.* ſlender or creeping-rooted Birthwort. The name Birthwort is applied alſo to two plants of another genus, the bulbous rooted Fumitories: The *Ariſtolochia rotunda vulgaris* or *cava*,

cava, is that called by Caſpar Bauhine *Fumaria bulboſa radice cavâ, major, flore rubro dilutiore:* The *Ariſtolochia fabacea* is the *Fumaria bulboſa radice non cava minor* of the ſame author. Of all the ſorts, the root is the part principally made uſe of: Thoſe of the *round* are pretty thick, unequal, full of round protuberances, ſometimes ſhaped like a kidney, externally brown, internally yellow like Boxwood: Thoſe of the *long* are alſo brown on the outſide and yellow within, near a foot in length, from two to three or four fingers in thickneſs, and full of wrinkles: Thoſe of the *creeping-rooted* are the longeſt and ſlendereſt, and of the darkeſt brown colour on the outſide; the largeſt are ſcarce ſo thick as the little finger, and the greater number ſcarce half ſo thick: The roots of the *Rotunda vulgaris* are about the ſize of Walnuts, pointed in the middle, brown without, hollow within: Thoſe of the *Fabacea* are no larger than Filberds, commonly flatted, externally yellow, internally mealy and white. BIRTHWORT.

In taſte they are all bitter and aſtringent, but in different degrees: The *Fabacea* is much the weakeſt, and the ſlender rooted ſort the ſtrongeſt. Hence they differ alſo in medicinal virtue: Simon Paulli obſerves particularly of the long-rooted, that a decoction of it in the diſtilled water of Veronica is of excellent ſervice againſt ulcerations on the ſhinbone, and ſays he has received the thanks of many ſurgeons for the communication of this medicine.

With regard to their chemical analyſis, they all give out more to water than to ſpirit: An ounce yields with ſpirit ſomewhat more than a dram of reſinous extract, whilſt the ſame quantity, treated with water, gives upwards of two drams of a gummy one. The ſpirituous extract taſtes ſtrongly of the root, but the watery has very little taſte. In diſtillation, rectified ſpirit brings over nothing from the root; the diſtilled water has a diſagreeable kind of ſmell, different from that of the Birthwort itſelf.

The leaves of one of the Birthworts, namely of the long ſort, are ſometimes alſo employed medicinally. Theſe are of the ſhape of a heart, full of veins, both longitudinal and tranſverſe, and of an extremely ſtrong ſmell. They give out conſiderably more than the roots do to rectified ſpirit, and ſomewhat more to water: From an ounce were obtained two drams of ſpirituous, and from another ounce two and a half of watery extract.

It has been affirmed, that the fixed alcaline Salt obtained from Birthwort by burning, is of a peculiar kind; that it does not, like other fixed alcalies, throw down a yellow Precipitate from ſolution of Mercury-ſublimate. Tournefort mentions this particularity of the *Clematitis* or ſlender-rooted ſort, and ſays he took it from the experiments upon the regiſters of the French Academy. I have tried the experiment, and found that the ſmalleſt portion of the Salt of Birthwort, added to a ſolution of Sublimate, throws down a yellow Precipitate equally with the alcaline Salts of other plants.

THE leaves of common WORMWOOD (*Abſinthium vulgare majus J. B.*) are intenſely bitter, and have a ſtrong ſmell, ſomewhat of the aromatic kind, but ungrateful. They yield in diſtillation a conſiderable quantity of eſſential Oil, of a dark greeniſh colour, poſſeſſing the whole of their ſmell, the bitter matter remaining in the extract. WORMWOOD.

THE

V. CAMOMILE. Common.

THE flowers of the common CAMOMILE (*Chamæmelum vulgare, leucanthemum dioſcoridis C. B.*) contain alſo a bitter ſubſtance joined with an eſſential Oil of a peculiar ſtrong flavour.

The quantity of Oil is very ſmall, a whole pound of the flowers yielding ſcarcely above a ſcruple: It reſides, not in the white petala, nor in the yellow diſk, but ſolely in the cup of the flower. This Oil appears of a beautiful deep blue colour; not as ſome have ſuppoſed from its diſſolving a part of the Copper veſſel in which theſe kinds of diſtillations are uſually performed, for it proves of the ſame colour when drawn in glaſs ones: By age, its fine colour gradually decays, and changes at laſt to a browniſh or a greeniſh yellow. Hoffmann reports that the genuine Oil of Camomile will not continue blue above a year, and that ſuch as holds its tincture longer than that time has received it from art: But on trial, the genuine as well as the counterfeit Oil, if kept in bottles quite full and cloſely ſecured from the air, are found to retain their colour for two or three years or more, and both of them to loſe it in a ſhort time if there is any vacuity in the veſſel, or if the air is admitted: The blue colour of the counterfeit is deſtroyed by air, and changed to a green, even ſooner than that of the genuine.

An ounce of the dry flowers yielded with Spirit of Wine three drams, and afterwards with Water two drams of extract: Water applied at firſt extracted, from the ſame quantity four drams, and Spirit afterwards one dram: The indiſſoluble reſiduum weighed in both caſes three drams.

Simon Paulli obſerves that theſe flowers contain a manifeſt ſaline ſubſtance; that when digeſted and boiled in Wine, and two or three freſh parcels boiled in the ſame liquor, the Wine preſſed out from them taſtes at length notably ſaline. I repeated this experiment, and found the liquor to be of a truly ſaline taſte, approaching in ſome degree to that of common Salt. I therefore tried it with a ſolution of Silver and of Quickſilver: It occaſioned a precipitation in both, but the precipitate of the Silver was not a *Luna cornea*, nor that of the Mercury ſimilar to Corroſive Sublimate, which they would have been if the Salt had been of the marine kind. It is probable, that the Salt proceeded in good meaſure from the Wine, though the taſte of the decoction was different from that of boiled Wine by itſelf.

Camomile flowers are ſuppoſed to have an antiſpaſmodic and mild anodyne virtue, depending on their Oil: Their bitter matter is ſimilar in quality to that of Wormwood, Gentian, Centaury, *&c.* The oil, as already obſerved, is lodged in the cup; the bitterneſs prevails chiefly in the yellow diſk of the flower.

Roman.

The flowers of the Roman Camomile *Chamæmelum nobile ſive leucanthemum odoratius C. B.*) have a ſtronger and more agreeable ſmell than thoſe of the common. They yield a larger quantity of eſſential Oil, but the Oil has nothing of the fine blue colour of the other. The quantity of gummy and reſinous matter is almoſt exactly the ſame in both.

VI. ORANGE and LEM. PEEL.

THE outer yellow rind of the PEELS of ORANGES and LEMONS contains a bitteriſh matter, accompanied with a very fragrant aromatic Oil, ſo volatile as to ariſe in diſtillation with rectified Spirit as well as with Water. The Oil

drawn with Spirit is the moſt elegant of the two, and that from the freſh Peels more ſo than from the dry: But none of the Oils prepared by diſtillation are equal to that extracted by puncture or ſcarification (ſee page 271.) ORANGE and LEM. PEEL.

All eſſential Oils are imbibed readily by pure dry Sugar, and unite with it into a compound ſoluble in Water: In this form, called *Elæoſaccharum*, they are often made uſe of in medicine: An elæoſaccharum of Orange and Lemon-peel may be obtained, by rubbing the fruit upon a lump of Sugar till all the yellow part is abraded, and then ſcraping off ſo much of the Sugar as appears impregnated with the Oil.

VII. MILFOIL.

THE flowers and tops of the common purpliſh-flowered MILFOIL or yarrow (*Millefolium vulgare purpureum minus C. B.*) afford a beautiful blue Oil ſimilar to that of Camomile. The white flowered ſort yields an Oil of the ſame flavour with the other, but which has nothing of its colour.

Theſe flowers have a not diſagreeable aromatic ſmell, and a roughiſh, biteriſh, ſomewhat pungent taſte: The bitterneſs and aſtringency remain in the extracts, whether made by Spirit or by Water. An ounce of Milfoil tops yielded with Water three drams and a ſcruple, and afterwards with Spirit only ſix grains: Spirit applied at firſt extracted, from the ſame quantity, two drams and a half, and Water afterwards one dram thirty-ſeven grains: The indiſſoluble reſiduum weighed in the firſt caſe four drams thirty-ſeven grains, in the latter forty grains leſs——This plant is looked upon as an excellent corroborant and antiſpaſmodic.

VIII. PIMPINELLA NIGRA.

THERE is another plant which affords a blue Oil that ariſes not only with Water, but with highly rectified Spirit of Wine; the *Pimpinella nigra* or BLACK BURNET-SAXIFRAGE. This plant has not hitherto been deſcribed by the botaniſts: It appears to be a ſpecies of *Tragoſelinum*, and may not improperly be called *Tragoſelinum majus radice nigra:* Perhaps it is the *Tragoſelinum alterum majus* of Tournefort, *Pimpinella Saxifraga major altera* of Caſpar Bauhine, *Saxifragia hircina minor foliis ſanguiſorbæ* of John Bauhine, *Tragoſelinum minus*, *Pimpinella minor* of Tabernæmontanus. Its leaves are ſomewhat different from thoſe of the *Pimpinella alba* (page 341.) but the principal difference is in the roots, which inſtead of being of a white colour throughout, are black on the outſide, and variegated internally with bluiſh veins. As the French chemiſts called in queſtion the blue Oil of this root, I ſent them a ſpecimen of the Oil drawn by myſelf, of its blue diſtilled ſpirit, and of the entire plant with its root, flowers and ſeeds; with a quantity of roots for repeating the experiments, and a quantity of freſh ſeeds for propagating the plant. The Spirit ariſes blue only about the middle of the diſtillation, the firſt and the laſt runnings being colourleſs: If theſe are kept apart, the Spirit proves of a deep blue colour; if the whole is mixed together, very pale. The diſtilled Water has no blueneſs. The Oil, like thoſe of Camomile and Milfoil, ſoon loſes its blue colour in the air, changes to a green, and at laſt to a yellow.

This black Pimpinella-root has the ſame ſmell and taſte with the white ſort formerly examined: It yields alſo the ſame principles on extraction with Water and with Spirit, but in ſomewhat different proportions. From two ounces

PIMPINELLA NIGRA. were obtained by rectified Spirit three drams of a reſinous extract, more unctuous or oily than that of the white Pimpinella, and afterwards by Water three drams of a gummy extract: Water applied at firſt extracted five drams, and Spirit afterwards only one: The reſiduum, in both caſes, weighed ten drams.

IX. CALAMUS AROMATICUS, or *Acorus Verus*, is the root of a kind CALAMUS AROMAT. of flag growing in marſhy places in ſome parts of Europe: It is pretty long, full of joints, of a whitiſh, reddiſh, and partly of a greeniſh colour on the outſide, white and ſpongy within, eaſy to break, of a ſtrong aromatic ſmell, and a warm pungent taſte. In firm grounds, it ſpreads into many ſlender ſtrings, which in mere watery ones it does not.

The diſtinguiſhing taſte and grateful flavour of this root reſide wholly in the eſſential Oil, the decoction remaining after the diſtillation of the Oil having a nauſeous taſte not at all like that of the Calamus: From ſixteen ounces of the dry root little more than two ſcruples of Oil are obtained: From the freſh roots we can ſcarcely collect any, the Oil remaining all diſſolved in the diſtilled Water. Hermann reports that the Oil and Water of Calamus Aromaticus are highly ungrateful, but they are quite the reverſe: Nor do the old decayed roots, which Wedel ſuſpects Hermann's Oil and Water to have been drawn from, give any thing diſagreeable in diſtillation.

Highly rectified Spirit elevates little or nothing of this Oil: Hence a ſpirituous extract made from the root ſmells conſiderably, and taſtes ſtrongly, of the Calamus. Two ounces yielded with Spirit ſix drams and half a ſcruple, and afterwards with Water three drams ten grains of extract: Water applied at firſt extracted, from the ſame quantity, ſeven drams thirty-five grains; and Spirit afterwards forty three grains.

X. CYPERUS (*Cyperus rotundus Orientalis major C. B.*) is the root of a plant CYPERUS. approaching to the flag kind, brought from the eaſtern countries: It is nearly of the ſhape of an Olive, of a reddiſh brown colour on the outſide, of a reddiſh white within, compact, pretty ponderous, of an agreeable aromatic ſmell and taſte, with a ſlight bitterneſs and aſtringency. The French, inſtead of this, uſe commonly a root of their own growth (*Cyperus rotundus vulgaris C. B.*) which does not greatly differ from the Oriental: This ſort is found alſo in Switzerland, Italy, and ſome other parts of Europe.

The ancients employed Cyperus as a Spice: At preſent it is ſometimes uſed medicinally, but chiefly as an ingredient in hair powders, ſweet-ſcented powders for clothes, and other like purpoſes. The quantity of Oil it contains is very ſmall: From an ounce or two of the root we can ſcarcely collect any. Rectified Spirit of Wine elevates nothing of this Oil, but diſtils flavourleſs as it was employed: Hence the ſpirituous extract retains the flavour as well as the taſte of the root, though the watery extract is rather ſtronger in taſte.

Two ounces of the root yielded with Spirit three drams of extract, and afterwards with Water three drams and a ſcruple; The ſame quantity, treated firſt with Water, gave ſix drams, and afterwards with Spirit half a dram:

The

The indiſſoluble earthy matter weighed in the firſt caſe nine drams two ſcruples, and in the latter nine drams and a half. CYPERUS.

XI. ZEDOARY.

ZEDOARY is the root of a plant ſaid to be of the Ginger kind, growing in different parts of the Eaſt Indies, and brought to us chiefly from Bengal. There are two ſorts of it, a long and a round: The firſt, which is accounted the beſt, is about the ſize of the little finger, ſometimes larger and ſometimes ſmaller, of a whitiſh and yellowiſh grey colour, darker on the outſide and lighter within, compact and firm, of an aromatic ſmell and taſte ſomewhat approaching to thoſe of Roſemary and Camphor, accompanied with a degree of bitterneſs.

Sixteen ounces of this root yield about a dram, ſeldom more, of eſſential Oil, poſſeſſing the whole of its ſmell and aromatic flavour; the bitterneſs remaining in the decoction. The Oil is very ponderous, ſinks in Water, and difficultly ariſes in diſtillation: The more ſubtile part which comes over firſt is almoſt colourleſs; the reſt is partly greeniſh, and partly blackiſh. Rectified Spirit elevates a little of its finer parts, but does not receive near ſo ſtrong an impregnation as Water does; and hence the ſpirituous extract retains much of the peculiar flavour of the Zedoary, which in the watery is wholly loſt.

Sixteen ounces yielded of watery extract five ounces five drams and one ſcruple; after which, Spirit extracted about two drams two ſcruples of an almoſt inſipid Reſin. The ſame quantity, treated firſt with Spirit, gave an ounce and a half, and afterwards with Water full five ounces: This laſt extract taſted much bitterer than that obtained by applying Water at firſt.

XII. GINGER.

GINGER is the produce both of the Eaſt and the Weſt Indies. Two ſorts of this root are brought to us, one internally white, the other brown: Whether they are the roots of different ſpecies of the Ginger-plant, or of one ſpecies taken up at different ages or in different ſeaſons, is not certainly known. This pungent aromatic is of common uſe as a Spice, and is obſerved not to heat the conſtitution near ſo much as might be expected from its ſtrong biting taſte. Its pungency reſides not in its volatile but in its fixed parts: The eſſential Oil contains the ſmell and diſtinguiſhing flavour of the Ginger, but all the pungency is left behind in the ſtill.

brown.

From ſixteen ounces of the common brown Ginger may be obtained a dram or a little more of Oil. The ſame quantity yielded, with rectified Spirit, an ounce and two ſcruples of reſinous extract, containing all the hot biting matter of the root: From the reſiduum, Water extracted a ſtrong mucilage, which had little or no taſte, was difficultly reduced to dryneſs, and weighed, when exſiccated, five drams and a half. Sixteen ounces, treated firſt with Water, gave four ounces of extract conſiderably pungent, a portion of the reſinous matter being taken up by the Water along with the gummy: From the reſiduum, Spirit extracted five ſcruples four grains of a very pungent Reſin. The indiſſoluble earthy matter amounts to near three fourths of the root, *viz.* eleven ounces ſix drams and ſixteen grains. Rectified Spirit elevates in diſtillation ſome of the more ſubtile parts of the Oil, ſo as to taſte a little of the Ginger, though not conſiderably.

GINGER. white. The white Ginger contains more ſoluble matter than the brown. From ſixteen ounces of this ſort were gained five ounces five drams and a ſcruple of watery, and afterwards three drams twelve grains of ſpirituous extract. Spirit applied at firſt extracted one ounce and three drams wanting a few grains; and Water applied afterwards took up four ounces and a half; ſo that the indiſſoluble part does not amount quite to ten ounces on ſixteen. The quantity of eſſential Oil is nearly the ſame as in the brown ſort.

XIII. GALANGAL. larger. THE greater GALANGAL, an Eaſt Indian knotty root with ſeveral circles on the ſurface, of a reddiſh brown colour on the outſide and a yellowiſh white within, greatly reſembles Ginger in its ſmell, taſte, and chemical compoſition; but as Ginger is the moſt grateful of the two, the Galangal is ſcarcely ever uſed.

ſmaller. The ſmaller Galangal, which is knotty and marked with circular ſtriæ like the other, commonly about the ſize of the little finger, and of a brown colour both externally and internally, is in ſmell ſtronger and more agreeable than the large, and in taſte more pungent and hot like Pepper. It contains but a ſmall proportion of Oil: Sixteen ounces afforded ſcarcely two ſcruples; though probably if conſiderable quantities were diſtilled at once, and the diſtilled Water of one operation employed inſtead of freſh Water in the next, the yield upon the pound would be greater. The Oil is leſs agreeable in ſmell than the Galangal itſelf, and wants its pungency, which of conſequence remains in the extract. Very little of this Oil ariſes with rectified Spirit: The Spirit diſtilled even from a large quantity of the root, has ſcarcely any taſte or ſmell. With regard to the extracts, the watery is rather more pungent than the ſpirituous; but the former have nothing of the peculiar flavour of the Galangal, greateſt part of which is retained in the latter. Sixteen ounces yielded with Water ſix ounces, and afterwards with Spirit four drams two ſcruples: Spirit applied at firſt extracted an ounce and a half from ſixteen, and Water extracted afterwards five ounces.

XIV. CLOVES. THE CLOVE tree, *Caryophyllus aromaticus fructu oblongo C. B.* is a native of the Molucca iſlands, and has not been found to thrive ſo well in any other part even of the Eaſt-Indies. It is about the ſize of a large cherry-tree: The leaves are ſomewhat like thoſe of the bay, and the wood like boxwood. The Clove-ſpice has been ſuppoſed by ſome to be the flowers, by others the fruit of the tree, but it does not appear to be either of theſe: It is ſtrictly the cup of the unexpanded flower, as Dr. Schrœck firſt obſerved in the *Ephemerides Naturæ Curioſorum*.

The manner of fructification of the Clove-tree may be underſtood from that of the common Dog-roſe. The Dog-roſe puts forth, at the ends of the branches, roundiſh buttons, which open at the extremity into ſeveral pointed ſegments, ſurrounding a little knob, which gradually unfolding becomes the flower: When this falls, the button, which ſerved for its cup, becomes the fruit. The Clove-tree, inſtead of a round, has an oblong cup like a nail, four points at the end turning outwards and forming the head: This is at firſt green; when the rudiments of the flower begin to ſhew themſelves in the

the middle of the points, it turns reddiſh or browniſh, and in this ſtate is the Clove-ſpice. CLOVES.

Some report that the Cloves fall off of themſelves, others that they are ſhaken, and others that they are beaten off. There is little probability of their being procured by any of theſe means: Theſe cups, as thoſe of other flowers, adhere firmly to the plant: by beating, they would be bruiſed or broken, or at leaſt loſe the flower buds at the end, which eaſily come off, and which are ſtudiouſly preſerved. We cannot ſuppoſe them gathered any otherwiſe than by hand. Nor is it probable, that they are dried in ſmoke, or dipt in Sea-water before the drying; for both theſe would be injurious to them.

Cloves, as brought to us, are externally of a reddiſh brown colour, internally of a paler yellowiſh, of a ſtrong aromatic ſmell, and a very hot pungent taſte: They are eaſily broke by the fingers, which they impregnate at the ſame time with their ſmell: On piercing them with a needle, a little liquid matter like Oil oozes out; a mark of the goodneſs of the Cloves. The Dutch, who are the maſters of the Clove iſlands, diſtil large quantities of the Oil of Cloves upon the ſpot, and ſupply the other parts of the world with the eſſential Oil as well as with the Spice in ſubſtance: The Cloves that have been thus robbed of their Oil they mingle with freſh Cloves, from which they acquire a conſiderable ſhare of ſmell. A light brown colour gives ſuſpicion of this abuſe, and if we examine theſe pale ones by themſelves, we ſhall eaſily find whether they retain or have loſt their native Oil.

The Dutch Oil of Cloves is extremely hot and fiery, and of a reddiſh brown colour, and theſe are in general looked upon as characteriſtics of its genuineneſs. This Oil, however, in its pure and perfect ſtate, is very far from having either of theſe qualities. When newly diſtilled it is colourleſs; by long keeping, in glaſſes not quite full or not ſufficiently ſecured from the air, it becomes more and more yellow or brown. It ſmells exceeding ſtrongly of the Cloves, but its taſte is quite mild in compariſon to that of the Dutch Oil.

The pungency of this Spice reſides in the Reſin, or rather in a combination of the Reſin with the Oil: The ſpirituous extract is exceſſively fiery: but if this extract be freed from its Oil by diſtillation with Water, the Oil that ariſes proves mild, and the remaining Reſin inſipid. The ſhare of heat and pungency which the Oil does retain, ſeems to proceed wholly from a portion of the Reſin elevated along with it; we can free it ſo far from reſinous matter that it ſhall be equally ſoft and inſipid upon the tongue with Oil of Almonds, its ſmell ſtill continuing.

The Dutch Oil of Cloves is largely adulterated: From an ounce I have ſeparated no leſs than half an ounce of an inſipid and inodorous expreſſed Oil. As this addition renders the genuine Oil ſtill milder, they muſt neceſſarily employ ſome other to give it fieryneſs; and this is probably the ſpirituous extract, which I have found to communicate at once both the pungency and high colour.

Where genuine Oil of Cloves is wanted, for medicinal or other uſes, we muſt diſtil it ourſelves, and this we may do with eaſe. I know of no herb, root, bark, fruit or ſeed, that yields ſo much: From ſixteen ounces of Cloves I obtained two ounces two drams: Hoffmann gained two drams more. It is con-

CLOVES. convenient to uſe a low head, to return the diſtilled Water upon the remaining Cloves, and to repeat the diſtillation two or three times; this Oil being very ponderous, ſo as not readily to ariſe. It conſtantly ſinks in Water, tho' Pomet and Valentine make it a mark of its goodneſs to ſwim. Pure Spirit of Wine elevates nothing of it, whether the Spirit is drawn over from the Oil itſelf or from the Clove in ſubſtance. The decoction remaining after the diſtillation of the Oil yields, on being inſpiſſated, a nauſeous ſomewhat aſtringent extract, amounting to ſix drams and a ſcruple from two ounces of Cloves: The ſame quantity yields, of ſpirituous extract, only about five drams.

ANTOPHYLLUS. THE fruit of the Clove-tree (called ANTOPHYLLUS) is of an oval figure, with an umbilicus or crown at the extremity, from the remains of the flower. It conſiſts of a ſkin or membrane, including a kernel about the hardneſs of a Bay-berry. It is much weaker than Cloves both in ſmell and taſte, though ſome have injudiciouſly preferred it to them. The active matter of the Clove or cup reſides chiefly in its cortical part: As the Clove increaſes, this matter is partly altered or diſſipated, and partly propelled more and more outwards, till, in the fruit, all of it that remains is confined ſolely to the exterior ſkin, the kernel having nothing of the Clove flavour.

XV. PIMENTO. AMOMUM is an exotic fruit, commonly ranked among the ſeeds. There have been different conjectures about the Amomum of the ancients, and different ſubſtitutes propoſed in the room of that unknown Spice. The Amomum of the German ſhops is an American berry, called by the Engliſh JAMAICA PEPPER, Pimento, or All-ſpice; by ſome *Piper chiapæ*, *tavaſci*, *odoratum*, *Grana caryophylli*, *Baccæ pantaromaticæ*.

The Jamaica Pepper-tree is a native of the iſland whoſe name it bears, particularly of the hilly tracts on the north-ſide. It riſes to the height of about thirty feet, covered with an extremely ſmooth grey bark: It is full of branches, clothed with dark ſhining green leaves, pointed at both ends, of an aromatic ſmell when rubbed, like that of the common Bay-leaves: On the extremities of the branches come forth cluſters of flowers, each ſtanding on a ſeparate pedicle, compoſed of four pale green herbaceos petala, with ſeveral ſtamina in the middle: The berries have a crown on the top, compoſed of four little leaves; at firſt they are green; when ripe, they are black, ſmooth and ſhining, and larger than Juniper-berries: Internally they contain a moiſt, green-coloured, pungent, aromatic pulp, and two hemiſpherical ſeeds or kernels, joined together by the flat ſides, with a ſkin between them. The berries are gathered in their unripe ſtate, and dried in the ſun; by which their green colour is changed to a yellowiſh, browniſh, and at length to a reddiſh or ruſty brown, or a dark brown.

Such is the Pimento-tree as deſcribed by Sir Hans Sloane in the Philoſophical tranſactions, No. 292, under the name of *Myrtus arborea aromatica, foliis laurinis* (aromatic Tree-myrtle, with Bay like leaves.) Plukenet and Dale make the true Pimento the produce of a different Species. The former diſtinguiſhes Sloane's tree by the name of *Caryophyllus aromaticus Americanus, lauri acuminatis foliis, fructu orbiculari*, (American Clove-tree, with acuminated

nated leaves like thoſe of the Bay, and a round fruit;) and the tree, which he propoſes himſelf, by that of *Caryophyllus aromaticus Americanus, foliis & fructibus rotundis, dipyrene, feminibus fere orbiculatis planis*, (American Clove-tree, with round leaves and fruit, and in each berry two roundiſh flat ſeeds). In his *Almageſtum* he mentions a third ſpecies, *Caryophyllus aromaticus Americanus, folio & fructu oblongo, polypyrene, acinis anguloſis uvarum vinaceis ſimilibus*, (American Clove-tree, with oblong leaves and fruit, angular ſeeds like thoſe of grapes, and more than two in one berry). But theſe are probably rather varieties than different ſpecies, as Sir Hans, a very ſkilful botaniſt, and who lived many years on the ſpot, refers them all to the tree which he deſcribes. PIMENTO.

Thus much is certain, that the berries of the ſeveral trees are uſed promiſcuouſly. Among thoſe brought to us, we may diſtinguiſh not only different ſizes, from their age or degree of maturity, but differences in ſhape, in the appearance of the crown or navel, and in the figure and number of the kernels. Some are round, ſome oval, ſome Pear ſhaped, and others flatted: In ſome the crown is flat, in others elevated: The ſeeds are in ſome hemiſpherical, in ſome angular, in others flat, approaching to a Kidney ſhape: The number of ſeeds is moſt commonly two, ſometimes three, four, or more; rarely or never one. Cluſius indeed makes but one ſeed in each berry, but he was deceived by the two joined together. I have obſerved alſo another ſort, not mentioned by Sloane, Plukenet, or any other author I know of: Inſtead of the berries ſtanding all on diſtinct pedicles, there are three, four, or more, upon one; and theſe flatted in a ſingular manner, with always a piece of the main ſtalk projecting beyond them. I have ſometimes found among the berries ſmall particles of Reſin, in appearance reſembling Myrrh, but differing from it in taſte; adhering ſtrongly to the berry, from which it had probably been melted out by the ſun's heat.

The ſeveral ſorts of theſe berries, however different in appearance, agree in quality. They have a pleaſant aromatic ſmell and taſte, compoſed as it were, of thoſe of Cloves, Nutmegs, Cinnamon, Pepper and Juniper-berries: The Clove flavour prevails above the reſt. The beſt are thoſe whoſe ſmell and taſte are the ſtrongeſt. They are uſed in large quantity in England, rather as a common Spice than in medicine: They are preferred to moſt other ſpices, as being of a milder nature, and leſs apt to heat the conſtitution.

With regard to the component parts of Jamaica Pepper, we find little or nothing in books, except that Sloane has mentioned that an Oil may be diſtilled from it. Upon a chemical examination it appeared to conſiſt of (1.) An indiſſoluble earth, exceeding in quantity all the other principles taken together, and amounting to five drams and a ſcruple upon an ounce. (2.) Gummy or mucilaginous matter, which is the ingredient next in quantity. An ounce, treated with water at firſt, gave two drams and two grains of gummy extract; and another ounce, freed by rectified ſpirit from all that that menſtruum could diſſolve, yielded ſtill with water five ſcruples of Mucilage. (3.) A reſinous ſubſtance in ſmaller quantity. The reſinous extract obtained by applying rectified ſpirit at firſt, amounted to only one dram and ſix grains from an ounce: An ounce, freed from its mucilaginous matter by coction in water, yielded of pure Reſin no more than one ſcruple. (4.) An eſſential Oil, in ſtill ſmaller quantity:

PIMENTO. quantity: Of this principle, an ounce contains ſcarce half a dram, or one ſixteenth.

Upon examining the qualities of the ſeveral products, it appeared, (1.) That the Oil is the principal and the characteriſtic part, containing all the ſmell and the aromatic flavour, though not the pungency of the berry. As the prevailing flavour of Pimento approaches to that of Cloves, the Oil alſo greatly reſembles the genuine Oil of that ſpice: It has the ſame kind of ſmell and taſte, diſcovers no great heat or pungency, and is ſo ponderous as to ſink in water: To which may be added, that the Oil of Pimento, like that of Cloves, reſides chiefly in the ſhell or cortical part, the internal ſubſtance yielding little or none. (2.) That the heat and pungency are lodged in the Reſin. In this reſpect alſo Pimento agrees with Cloves; but as Pimento in ſubſtance is far leſs hot and fiery than Cloves, its Reſin likewiſe is proportionably more mild. This Reſin differs further from that of Cloves, in having an ungrateful kind of taſte, ſomewhat like that of an extract made from green Walnut ſhells; and appearing, when pure, of a deep green colour. This colour is obſerved particularly in the tincture and extract made after the mucilaginous parts have been ſeparated by water: A ſingle grain of this extract tinges half an ounce of ſpirit. The colour proceeds from the green pulp; and as nothing of it is diſcoverable in the watery extract made after ſpirit, we may conclude that this pulp, or at leaſt its colouring matter, is a true Reſin. (3.) That the gummy parts have very little activity. An extract made by water at firſt contains a little Reſin along with the Gum, as one made by ſpirit at firſt contains ſome Gum along with the Reſin. Hence the ſlight taſte of the firſt watery extract, and the pale unequal colour of the firſt ſpirituous extract.

Rectified Spirit of Wine elevates nothing from this ſpice in diſtillation, the Oil of Pimento being too ponderous to ariſe with ſo light a fluid. The only way of making a ſpirit from it is, to diſſolve ſome of the Oil in pure Spirit of Wine: An agreeable ſpirituous water may be obtained by ſimple diſtillation with proof ſpirit, the watery phlegm in that liquor, carrying up a part of the Oil.

XVI. PEPPER. Black. BLACK-PEPPER is the fruit of a climbing plant growing in Malabar, Java, and other parts of the Eaſt-Indies. The eſſential Oil of this Spice has a ſtrong and a very durable ſmell, but in taſte it is one of the mildeſt of the diſtilled Oils, having no conſiderable pungency or heat. It is elevated in part by rectified Spirit of Wine, the diſtilled ſpirit being impregnated with the flavour though not with the pungency of the Pepper. The ſpirituous extract is exceſſively fiery: The watery alſo is very hot and biting, but this menſtruum cannot be made to extract all the hot matter of the Pepper: Four ounces of Pepper treated with more than twenty freſh quarts of water, ſtill retained a biting taſte; what the water extracted, ſo long as it extracted any thing, was likewiſe biting.

Sixteen ounces of Pepper yielded with water ten ounces of gummy extract, and afterwards with rectified ſpirit three drams of Reſin: Another pound, treated firſt with ſpirit, gave two ounces two drams of reſinous extract; and afterwards with water ſeven ounces four drams two ſcruples of gummy matter:

This

This laſt extract had ſtill ſome degree of pungency, rectified ſpirit ſeeming not to take up all the active parts any more than water. Of eſſential Oil, I have gained two drams and a half from a pound. PEPPER.

The White-pepper has the ſame kind of taſte and flavour with the black, but in a much leſs degree. It agrees alſo with the black in the nature of its chemical principles, only the flavour reſiding in the diſtilled Oil, and the pungency and heat in the matter left after the diſtillation. In effect, it is the very ſame fruit, gathered before it has grown fully ripe, and freed from the outer ſkin by ſteeping in water and then rubbing it. White.

CUBEBS, *Cubebæ*, are ſmall dried ſhrivelled berries, of Indian growth, greatly reſembling Pepper-corns, but with this difference that each Cubeb is furniſhed with a pedicle, whilſt the Pepper-berries come forth cloſe upon the ſtalk without pedicles: Hence Cubebs are called, not improperly, *Piper caudatum*. Of the plant which produces them, we have no ſatisfactory account. XVII. CUBEBS.

Cubebs are in ſmell ſomewhat different from Pepper, in taſte ſimilar, but leſs pungent. Their eſſential Oil is equally mild; the pungency, as that of Pepper, reſiding in the reſinous parts; but rectified ſpirit, which elevates in diſtillation a part of the Oil of Pepper, brings over nothing from Cubebs.

Two ounces of Cubebs yielded with rectified ſpirit five drams ten grains of extract, and afterwards with water four drams thirty-two grains, ſix drams and a half remaining undiſſolved. The ſame quantity, treated firſt with water, gave ſix drams and a ſcruple, and afterwards with ſpirit only one dram and one grain: The reſiduum weighed ſeven drams two ſcruples. Wedel relates that three pounds afford two ounces and a half of eſſential Oil.

GRAINS OF PARADISE have been ſuppoſed to be the ſeeds of the larger Cardamom formerly mentioned (page 402.) but very erroneouſly. In ſmell, taſte, and chemical compoſition, they are quite different from Cardamom-ſeeds. Grains of Paradiſe are pungent as Pepper; and their pungency does not reſide, like that of Cardamoms, in the eſſential Oil, but in the Reſin. The diſtilled Oil poſſeſſes their ſmell, but in taſte proves mild, whilſt the reſinous extract is exceſſively pungent, the ſmalleſt particle ſetting the tongue as it were on fire, and continuing to burn the mouth for ſome hours. XVIII. GRAINS OF PARADISE.

ROSEWOOD, *Lignum rhodium*, *aſpalathus*, a hard ponderous wood ſaid to be the produce of the iſland Rhodes, and ſome of the Fortunate Iſlands, approaches in ſmell to Roſes, and yields a delightful Oil commonly employed as a perfume. This wood is commonly crooked, twiſted as it were, unequal and full of protuberances, covered with a rough browniſh-grey bark, which eaſily comes off; the wood itſelf is of a whitiſh colour on the outſide, and of a darker browniſh, yellow, or orange colour within: It is chiefly in this laſt part that the Oil and other active matter reſide, and the yellower the colour the more Oil it contains. The Dutch carefully pick out for diſtillation the largeſt, ſmootheſt, leaſt twiſted and darkeſt coloured pieces. The ſmell of this wood is often not to be diſtinguiſhed in entire pieces, but on ſawing or raſping them acroſs, till we come to the yellow part, it never fails to diſcover itſelf. XIX. RHODIUM.

RHODIUM. Vielheuer relates, that a pound of Rhodium yielded an ounce of Oil: If this be true, the wood muſt have been of an extraordinary good kind. I have gained in England, three drams from a pound, never more, and for the moſt part not near ſo much. The common Oil of Rhodium is grievouſly adulterated, not as ſome ſuppoſe, by adding expreſſed Oils in the diſtillation, for in this caſe they would not ariſe with it, but by mixing them with it afterwards: From an ounce of the very beſt Oil of Rhodium I could procure for money, I ſeparated ſix drams two ſcruples of expreſſed Oil; and there was reaſon to believe, that even the remaining four ſcruples were not purely from the Rhodium. The Oil ariſes in diſtillation very ſlowly and difficultly, requires a ſtrong boiling heat, and the diſtillation to be once or twice repeated, by returning the diſtilled water upon the reſiduum. The water is ſtrongly impregnated with the flavour of the Rhodium, and is uſed for the ſame purpoſes as Roſe-water: Rectified ſpirit brings over nothing from this wood, but diſtils a pure flavourleſs ſpirit as it was employed. Hence extracts made by water conſiſt only of the mucilaginous and bitteriſh matter of the wood (for the wood in ſubſtance has a ſenſible bitterneſs,) whilſt the ſpirituous retain all its volatile odorous parts.

An ounce of the raſped wood yielded with rectified ſpirit fifty-five grains of reſinous extract, and afterwards with water thirty grains of Mucilage: The ſame quantity, treated firſt with water, gave forty-five grains of mucilaginous extract, and afterwards with ſpirit twenty-five grains of Reſin: The indiſſoluble woody matter weighed in the firſt caſe ſix drams thirty grains, and in the latter ten grains more.

XX. YELLOW-SAUNDERS. YELLOW-SAUNDERS, *Santalum citrinum* or *flavum*, a compact heavy pale yellow wood brought from the Eaſt-Indies, is likewiſe employed principally in perfumes, though often alſo medicinally as a corroborant. It has an agreeable ſweet ſmell, ſomewhat of the muſky kind; and yields an Oil of excellent fragrance, though in no very large proportion: From ſixteen ounces of the raſped wood, digeſted ſome days in ſalt water, I obtained by cohobation two drams: It was of a thickiſh conſiſtence, approaching to that of a balſam.

Two ounces of this wood yielded with water two drams of gummy extract, and afterwards with rectified ſpirit one dram and a half of Reſin: Spirit, applied at firſt, extracted from the ſame quantity two drams and a half, and water extracted afterwards one dram. The diſtilled water contained the flavour of the wood, but from this ſmall quantity no actual Oil could be collected: The diſtilled ſpirit had no flavour, the reſinous extract retaining all the active parts of the Saunders.

XXI. SASSAFRAS. THE roots of the SASSAFRAS tree, a native of ſeveral parts of America, as Brazil, Florida, Virginia, *&c.* have a ſtrong aromatic ſmell reſembling that of Fennel. The ſmall branches approach in quality to the roots; the bark of the trunk is much weaker; the wood of the trunk has hardly any ſmell, and is employed only for mechanic uſes. The roots are brought over with the bark upon them, this being much ſtronger in ſmell than the woody part, whereas in

in ſome other odoriferous woods the bark is inodorous. The wood of Saſſafras is of a browniſh colour; the bark of a reddiſh-brown, unequal, eaſy to break: Both are remarkably light. SASSAFRAS.

Boerhaave's obſervation, that light woods eaſily exhale their Oil, does not obtain here, notwithſtanding he brings this very wood as an example of it. The Oil of Saſſafras ariſes very difficultly in diſtillation with water, and not at all with ſpirit: Notwithſtanding the lightneſs of the wood, the Oil is ſo ponderous as to ſink in water; Hoffmann finds that it is the heavieſt of all the eſſential Oils. This gentleman gained, from ſix pounds of the wood, an ounce and ſix drams of Oil: From the ſame quantity of middling Saſſafras I obtained two ounces, ſo that we may reckon at leaſt eight ſcruples upon the pound, or half a ſcruple upon an ounce.

An ounce of Saſſafras digeſted with rectified ſpirit yields four ſcruples of extract, and afterwards with water a dram: Water applied firſt extracts two drams, and ſpirit afterwards only ſeven grains and a half. The Oil is the moſt active part of the Saſſafras, and next to this the ſpirituous extract, which contains all the Oil along with the Reſin. Infuſions however, or ſlight decoctions, made like thoſe of Bohea Tea, are no contemptible preparations, the water by this treatment, extracting and retaining greateſt part of the virtue of the root.

The uſe of Saſſafras is almoſt wholly medicinal, as a corroborant and purifier of the blood. Ximenes relates, and from him Wormius, that this wood, macerated for a time in ſea-water, ſweetens or frees it from its ſaltneſs: Franciſcus Redi found from experiment that it had not this effect.

XXII. LIGNUM-ALOES.

LIGNUM-ALOES, *Xyloaloes*, *Agallochum*, is an oriental wood, very ſcarce and valuable in the Eaſtern countries, and very rarely brought into Europe, though the compilers of diſpenſatories direct it as an ingredient in ſundry compoſitions, and require it to be taken freſh and fragrant. The tree has hitherto eluded the enquiries of European travellers. It is ſaid, that the Lignum-aloes is the medullary part of the tree; and that there are different ſorts of it, of which only the worſt comes to us, the beſt being twice as dear upon the ſpot as ours is here. Rumphius relates, that the Chineſe counterfeit it with another Indian wood, boiled, or infuſed, with reſinous aromatic extracts.

Lignum-aloes is very differently deſcribed by different authors. The beſt that we meet with in this country is very compact, heavy, ſomewhat gloſſy, of a cheſnut-brown colour intermixed with a blackiſh and ſometimes a purple, in ſmell reſinous and balſamic: The largeſt, heavieſt, darkeſt coloured, and moſt reſinous pieces are preferred. I have ſeen a veſſel which held a quart made from one piece.

Half an ounce of this wood, raſped, yielded with rectified ſpirit five ſcruples and a half of reſinous extract, and afterwards with water one ſcruple of a gummy one: Another half ounce, treated firſt with water, gave three ſcruples and a half, and afterwards with ſpirit one dram: The indiſſoluble woody matter amounted in both caſes to five drams and a half. Hoffmann ſubmitted ten pounds of the raſped wood to diſtillation with water, and ob-

LIGNUM-ALOES. tained only half an ounce of eſſential Oil, which coagulated in the cold into a reſinous or Camphor-like conſiſtence.

XXIII. ELECAMPANE. THE roots of ELECAMPANE, *Enula campana*, *Helenium*, (*Helenium vulgare C. B.*) yield inſtead of a fluid Oil, a ſubſtance which concretes partly into ſnowy flakes, and partly into an unctuous conſiſtent maſs like ſoftiſh Wax.

On diſtilling thirty-two ounces of the root, I gained in all three ſcruples and a half; of which part ſtuck in the head of the ſtill, part in the worm, and part paſſed down into the receiver along with the water. I have not obtained ſuch a concrete from any other vegetable: It is not a true Camphor, though agreeing with it in ſeveral properties as well as in the manner of its production. It diſſolves in Spirit of Wine, and is not acted upon by water: Laid on burning coals, it totally exhales: Held over a gentle fire in a ladle, it flows like Wax or Tallow, and when cold appears ſofter and more unctuous than at firſt: It never aſſumes a cryſtalline form, but when thoroughly dry proves opake and crumbly: When newly diſtilled, it ſmells conſiderably of the Elecampane, but on keeping for ſome time, it loſes its more ſubtile parts, and no longer diſcovers any remarkable ſmell. I know of no one who has taken notice of this concrete, except the younger Geoffroy, who obſerves that it reſides in the exterior parts of the root, near to the bark.

The taſte of this root is bitteriſh and aromatic; its ſmell moderately ſtrong, and not diſagreeable. The moſt active preparation is the ſpirituous extract; rectified ſpirit bringing over nothing in diſtillation: Even the watery extract however is not deſtitute of activity, for water leaves more behind than it carries up. An ounce of the dry root yielded with water ſix drams and a half of extract: The ſame quantity gave with ſpirit only two drams and a half. After the ſpirit would take up no more, water extracted five drams; but the parcel that had undergone the action of water gave only five grains to ſpirit.

XXIV. SPIKENARD. INDIAN SPIKENARD (*Nardus Indica*, *quæ ſpica*, *ſpica nardi & ſpica Indica officinis C. B.*) conſiſts of a number of ſlender brittle filaments, ſuppoſed by ſome to be the root, by others the pedicle of the leaves, of a plant of the Graſs or Ruſh kind; but which are properly the head of a root, for Pomet mentions and figures a ſpecimen which had great part of the root itſelf adhering.

Spikenard has a very ſtrong, not agreeable ſmell and taſte, ſcarce to be concealed or overpowered by a large admixture of other ſubſtances: In the *Theriaca cæleſtis*, a compoſition of many drugs of ſtrong ſmells and taſtes, Spikenard enters but in ſmall quantity, and yet it prevails over all the others. It contains however only a ſmall proportion of eſſential Oil; On diſtilling an ounce, there was only an appearance of ſome oily particles on the ſurface of the water. Rectified ſpirit brings over nothing: The ſpirituous extract poſſeſſes both the ſmell and taſte of the Spikenard, in a much greater degree than the watery. An ounce yielded a dram of ſpirituous, and afterwards forty-ſix grains of watery extract: Water applied at firſt extracted from the ſame quantity four ſcruples, and ſpirit afterwards twenty-five grains: The indiſſoluble reſiduum weighed in both caſes ſix drams ten grains.

THE

XXV. FRENCH LAVENDER.

THE ARABIAN STÆCHAS (*Stæchas purpurea C. B.*) is a ſmall ſhrubby plant, growing not only in Arabia, but in ſome of the ſouthern parts of Europe, particularly in the Stæchades or Hieres iſlands on the coaſt of France. The flowery heads or ſpikes are an officinal drug: Theſe, when in perfection, are of a fragrant ſmell, and a bitteriſh taſte; but they are not gathered it ſeems till they are ready to ſhed the flowers, which in drying fall off completely, leaving nothing to be brought to us [at Berlin] but almoſt inodorous huſks.

An ounce of our beſt Stæchas yielded with rectified ſpirit a dram and twelve grains of extract, and afterwards with water five ſcruples and a half, the reſiduum weighing five drams all but two grains. On inverting the order of procedure, the watery extract weighed three drams ten grains, the ſpirituous only eight grains, and the reſiduum four drams forty grains. The ſpirituous extract contains the whole of the taſte and aromatic flavour: The watery extract taſtes alſo conſiderably of the Stæchas. The diſtilled water has nothing valuable, though the freſh flowers yield a portion of actual Oil.

XXVI. HYSSOP.

THE leaves of HYSSOP (*Hyſſopus officinarum cærulea ſive ſpicata C. B.*) yielded a dram and a half of Oil upon two pounds, the diſtilled water retaining alſo a conſiderable quantity, ſo as to ſmell ſtrongly of the herb. Rectified ſpirit elevates the more ſubtile parts of this Oil, but ſoon lets them go upon ſtanding, and loſes nearly all the ſmell which it had when newly diſtilled. The extracts have not much of the diſtinguiſhing taſte, any more than of the ſmell of the Hyſſop: The ſpirituous has more than the watery.

An ounce of the dried leaves gave half an ounce of watery, and afterwards twelve grains of ſpirituous extract: Rectified ſpirit applied at firſt extracted from the ſame quantity two drams, and water afterwards two drams more: The indiſſoluble matter weighed in both caſes half an ounce. This plant is chiefly recommended in coughs and obſtructions of the breaſt.

XXVII. FEVERFEW.

THE leaves of FEVERFEW (*Matricaria, Parthenium: Matricaria vulgaris ſeu ſativa C. B.* ſo called from their uſe in uterine obſtructions,) have a bitteriſh taſte, and a ſtrong ſmell, to moſt people diſagreeable, ſuppoſed to be peculiarly offenſive to bees, whence Paulli adviſes thoſe who expoſe themſelves to theſe inſects, to carry Feverfew as a defence.

Pure ſpirit elevates little of the Oil of this plant; and hence in the ſpirituous extracts, its diſtinguiſhing ſmell as well as taſte is preſerved. Water on the contrary elevates all the Oil, which partly remains diſſolved in the diſtilled water and communicates to it a ſtrong impregnation, and partly ſeparates in its proper form.

An ounce of the dried leaves yielded with rectified ſpirit three drams five grains of reſinous extract, and afterwards with water five ſcruples of a gummy one: Another ounce, treated firſt with water gave four drams and a ſcruple of gummy extract, and afterwards with ſpirit one dram of Reſin: The reſiduum in the firſt caſe weighed three drams ten grains, in the latter only two drams forty grains.

RUE,

XXVIII. RUE. RUE, broad and narrow leaved (*Ruta hortenſis latifolia C. B. & Ruta hortenſis altera ejuſdem,*) has a ſtrong diſagreeable ſmell, and a nauſeous, acrid, bitter taſte: Some have obſerved, that the freſh juicy leaves, bruiſed and applied to the ſkin, corrode and exulcerate it; but that when dry they have not this effect: They are uſed in medicine as a ſtimulating aperient and anthelmintic.

It is ſuppoſed, that the ſeeds and their capſules are more active than the leaves. Thus much is certain, that if the plant be diſtilled, ſeeds and all, when the ſeeds are about half ripe, it yields a larger quantity of eſſential Oil than at any other time. It is obſervable of this Oil, that it coagulates in the cold like Oil of Aniſeeds; a property, however, which does not conſtantly obtain, and which perhaps may depend upon the degree of maturity of the ſeeds.

Two ounces of the dried leaves yielded with rectified ſpirit five drams and a half of extract, and afterwards with water five drams wanting half a ſcruple, the reſiduum weighing five drams two ſcruples: Water applied firſt extracted from the ſame quantity nine drams, and ſpirit afterwards only two ſcruples, the reſiduum amounting to ſix drams and a ſcruple. The extracts made both by water and ſpirit at firſt, are bitter and acrid; the firſt ſpirituous is ſomewhat oily; the ſecond watery is manifeſtly ſaline. The diſtilled ſpirit has little or no impregnation from the Rue.

XXIX. SCORDIUM. THE leaves of SCORDIUM or Water-germander (*Chamædrys paluſtris canescens ſeu ſcordium officinarum Tourn.*) have a bitteriſh taſte, and a ſtrong ſmell reſembling that of Garlic. In diſtillation however, we cannot, from moderate quantities, collect any actual Oil, its proportion being very ſmall, ſo as to be almoſt wholly retained in the diſtilled water, to which it communicates the ſmell of the herb. Both the watery and ſpirituous extracts are bitter: The ſpirituous is the ſtrongeſt, and poſſeſſes the ſmell and flavour as well as the bitterneſs of the Scordium, pure ſpirit elevating nothing of its Oil in diſtillation.

An ounce of the dried leaves of Scordium yielded with water four drams and a half of gummy extract, and afterwards with rectified ſpirit fifteen grains of Reſin: Another ounce, treated firſt with ſpirit, gave three drams of reſinous extract, and afterwards with water five ſcruples and a half of Gum: The reſiduum in the firſt experiment weighed three drams fifteen grains, in the latter five grains leſs.

This plant is greatly celebrated as a diaphoretic and alexipharmac: In theſe intentions an eſſence or ſpirituous tincture of it is frequently made uſe of in Germany. A tincture made in highly rectified ſpirit contains more of the active parts of the Scordium, than one made with a phlegmatic ſpirit, though the latter, by diſſolving more of the mucilaginous parts, proves thicker and apparently more ſaturated: The firſt tincture is of a fine green colour, the other inclines more to a dark browniſh.

CLASS

CLASS VII.

SALINE VEGETABLES.

I. SALINE. Lemon juice, &c.

THE acid juices of fruits, as Citrons and Lemons, effervesce with and neutralize alcalies, dissolve the absorbent earths, and some metallic bodies, as Iron, Copper, and Lead. They contain besides their truly acid part, a large quantity of gross mucilaginous or unctuous matter: Hence the juices themselves, and most of the solutions made in them, are apt to grow soon mouldy in keeping. The metallic solutions are less subject to this inconvenience than the earthy, and some juices less than others: A solution of Iron in the juice of the apples called Golden-rennets, evaporated to a thick consistence, proves an elegant Chalybeate, which keeps well. The juices give over very little acid in distillation; nor have they been observed to crystallize into a solid Salt, like those of some acid herbs as Wood-sorrel (*l*).

II. SORREL.

WOOD-SORREL (*Acetosella, lujula, alleluja, oxys: Trifolium acetosum vulgare flore albo C. B.*) is a small plant, growing wild in woods and meadows: It is said to cover itself with its leaves on the approach of ill weather. The fresh leaves have a mild acid taste, much more agreeable than that of common Sorrel, without any remarkable smell. Their expressed juice is employed medicinally for cooling and quenching thirst; and the essential Salt, extracted from it by crystallization, for taking out iron moulds and spots of ink from linen; for this purpose, the stained part is dipt in water, sprinkled with a little of the powdered Salt, then rubbed on a pewter-plate, after which the spot is washed out with warm water.

Twenty pounds of fresh Sorrel-leaves yielded six pounds of juice; from which were obtained two ounces two drams and one scruple of crystalline Salt, together with two ounces and six drams of an impure saline mass. The matter remaining after the expression, being treated with water and with spirit, gave ten ounces and a half of watery, and afterwards five drams of spirituous extract: The indissoluble matter, from the whole twenty pounds, amounted to no more than three ounces and three drams.

The essential Salt has a great agreement with Tartar, and yields the same products on being examined by fire. It is not however, as some pretend, a true Tartar: The principal differences are, that it is sensibly more acid, turns Syrup of

(*l*) *Do not crystallize.*] It appears to be the mucilaginous parts of these juices that prevent the crystallization of the saline; and that the saline parts are capable of being purified from the mucilaginous. From the juices of Oranges and Lemons, I have separated the insipid Mucilage, and obtained the acid matter in form of a truly crystalline white Salt. Probably by the same management, the acid and sweet juices of other fruits might be made to afford perfect Salts retaining all the specific taste of the fruit.

How far the native acid juices agree or disagree with Vinegar and Tartar, the products of fermentation, is little known. They seem to approach nearest to the nature of Tartar, as being susceptible of a crystalline form, giving over little of their acid in distillation, and yielding in the residuum, a large portion of fixed alcali.

SORREL. of Violets red, whilſt Tartar makes no change in the colour, contains leſs oily matter, diſſolves more eaſily in water, and does not ſeparate from the ſolution. It holds near a dram of Oil upon the ounce: On diſtilling an ounce in a retort, a ſcruple of Oil is obtained in its proper form, the other two ſcruples being partly diſſipated in the operation, and partly imbibed by the ſpirit that comes over at the ſame time.

III. CASIA. THE ſweet ſaline ſubſtance of CASIA FISTULARIS (for it appears to be truly of the ſaline kind) diſſolves not only in water but in rectified Spirit of Wine. Caſia is the fruit of a tree growing in Egypt and in both the Indies: It is a large cylindrical pod or cane, containing, under a hard rind, a ſoft pulp lodged in a number of tranſverſe cells, with a flat roundiſh ſeed in each. The pulp is apt to grow ſour or mouldy upon long keeping, even before its extraction from the cane: Sometimes alſo it grows dry, ſo as that the ſeeds rattle in the cells upon ſhaking the pod; in this ſtate it is generally rejected, though the ſimple exſiccation cannot be of any prejudice, as nothing but the aqueous humidity exhales.

The pulp of Caſia, when in perfection, is of a ſhining black colour, a ſweet taſte followed by a diſagreeable reliſh, and a faint unpleaſant kind of ſmell. It is commonly extracted by bruiſing the pod, boiling it in water, and evaporating the ſtrained decoction to a due conſiſtence. Out of four drams of the dry pulp, water diſſolved three drams fifteen grains, and rectified ſpirit as much or very nearly ſo; but the ſpirit acted more ſlowly and difficultly than the water. The diſtilled water ſmelt and taſted a little of the Caſia; the ſpirit not.

This pulp is a gentle laxative, and very frequently uſed in that intention by the French: The doſe, to an adult, is two ounces diſſolved in ſome convenient liquor with the addition of a carminative to prevent its occaſioning flatulencies and gripes, which of itſelf it is very apt to do, eſpecially when grown ſouriſh. It is ſaid to tinge the urine, when taken in moderate quantity, green; and in a larger quantity, brown or blackiſh.

IV. CAROB. THE CAROB, *Caroba, ceratia, ſiliqua dulcis*, is a pod of the ſame kind, about a ſpan long, of a flattiſh figure, containing a brown coloured ſweet pulp, which is uſed by the Egyptians and Arabians as Sugar. The tree is found wild alſo in ſome of the ſouthern parts of Europe: It is raiſed among us in the gardens of the curious, but does not in this climate ripen its fruit.

The pulp of the Carob is diſſolved more effectually by water than by ſpirit. Out of ſixteen drams of the dry pulp, water took up eleven drams; rectified ſpirit extracted from the remainder only five grains, leaving five drams of mere ſhells or membranes. The ſame quantity, treated firſt with ſpirit, gave out but nine drams ten grains, and afterwards to water five ſcruples, five drams and ten grains being left. The watery extract is ſweeter and more agreeable than the ſpirituous: The ſpirituous extract made after water is manifeſtly unctuous: The watery extract made after ſpirit diſcovers ſome ſaline matter. The watery decoctions are of a reddiſh-brown colour, and in inſpiſſation turn almoſt black: The fruit gives a deep colour to many freſh parcels of water. Spirit on the other hand ſoon ceaſes to extract any tincture, and the firſt deepeſt tincture is

only of a yellowiſh-brown: Nevertheleſs, the ſpirituous extract made after water inclines to black. CAROB.

IT is probable that the ſweetneſs of LIQUORICE, and of vegetable ſweets in general, depends on a ſaline ſubſtance of the nature of Sugar, intimately blended, as Sugar is in the juice of the cane, with unctuous, mucilaginous, or reſinous matter. Rectified Spirit of Wine diſſolves the ſaccharine Salts; and as it takes up but little of the mucilaginous principle (the ingredient whoſe quantity is the greateſt,) the ſpirituous tinctures and extracts prove conſiderably ſweeter than the watery. The ſpirituous extract of Liquorice is exceedingly ſweet, the watery far leſs ſo. From two ounces of the dry root I obtained by rectified ſpirit only five drams, whilſt the ſame quantity yielded with water nine drams: After the ſpirit would take up no more, water extracted three drams and a half; but after the action of water, ſpirit gained only half a dram: The indiſſoluble earthy matter amounted in the firſt caſe to ſeven drams and a half, in the latter only to ſix and a half. The ſweetneſs of this root is accompanied with a ſlight bitteriſhneſs, which ſome ſuppoſe to be confined to the outer brown ſkin, but which is found to be equally diſtributed through the inner yellow part: The peeling of Liquorice is therefore entirely unneceſſary, unleſs for obtaining a paler coloured powder or a lighter tincture. V. LIQUORICE.

It has been ſaid that Liquorice is indiſpoſed to ferment, and hence it is recommended particularly to thoſe, who cannot well bear Sugar, Honey, or the more fermentable ſweets: Experiment ſhews however that it does ferment, and yield a truly vinous liquor.

The extract of Liquorice is a conſiderable article of commerce: It is made in large quantity in Spain, and in ſome parts of Germany, particularly at Bamberg. The Spaniſh, which is generally covered with Bay leaves, is the beſt and pureſt; the other has a large admixture of the rob or inſpiſſated juice of Plums, *&c.* A certain writer affirms that an ounce of the Bamberg extract, treated with water afreſh, will ſcarcely give out two drams, but I have never met with any ſo bad as this: An ounce gave upwards of ſeven drams, though it does not follow that the whole of that quantity was genuine extract of Liquorice, as the rob of Plums will diſſolve in water as well as that of Liquorice.

Out of an ounce of the Spaniſh extract, water diſſolved ſeven drams two ſcruples, only one ſcruple being left, from which ſpirit extracted nothing: Rectified ſpirit diſſolved but four drams two ſcruples out of an ounce; water extracted three drams from the reſiduum, a ſcruple remaining as before undiſſolved. An ounce of the Bamberg ſort yielded with water ſeven drams one ſcruple: The ſame quantity gave with ſpirit two drams fifty grains, and afterwards with water three drams and a half; two ſcruples in the former, and five in the latter caſe, remaining undiſſolved. The part which ſpirit took up contained nearly all the ſweetneſs; that which water extracted afterwards having ſcarcely any taſte. The Dutch ſupply us now with no ſmall quantity of what is called Spaniſh Liquorice, and do not fail to wrap it up in plenty of Bay-leaves.

VI. MULLEIN. THE flowers of many plants are remarkably ſweet: Thoſe of MULLEIN (*Verbaſcum mas latifolium luteum C. B.*) contain a Honey-like juice. An extract made by water from the flowers is exceedingly ſweet and pleaſant: In the ſpirituous extract, a kind of peculiar flavour is joined to the ſweetneſs. Twenty-four drams of the flowers yielded with water twelve drams and a half, and afterwards with rectified ſpirit one dram and a half: Spirit applied firſt, extracted from the ſame quantity nine drams, and water afterwards four and a half. The leaves of Mullein have no ſweetneſs, and contain leſs diſſoluble matter than the flowers: Twenty-four drams gave eight and a half of watery, and afterwards one and a half of ſpirituous extract: On inverting the order of applying the menſtrua, the ſpirituous extract weighed four drams and a half, and the watery ſix.

ANOMALOUS VEGETABLES.

ARUM. THERE are ſome vegetables which cannot be referred to any of the foregoing claſſes, nor indeed to any other, the principle, in which their peculiar qualities reſide, being as yet wholly unknown. The common ARUM or Wake-robin is a plant of extreme acrimony: The freſh root, ſlightly chewed, ſeems to burn and corrode the tongue; and oftentimes its pungent impreſſion continues for two or three days. The ſeat of this acrimony has hitherto eluded our enquiries: The diſtilled water and ſpirit have nothing of it, and the watery and ſpirituous extracts exceeding little; and yet the root is by theſe operations deprived of it.

Greateſt part of the acrimony is deſtroyed by ſimple exſiccation: The dry root appears white and farinaceous, and affects the tongue but little. In this ſtate it is given medicinally for attenuating viſcid juices: Formerly it was uſed as ſtarch for linen, before the diſcovery of that from wheat (*m*), and is ſaid to have occaſioned a rawneſs and ſoreneſs of the hands very difficultly relievable by ointments: In ſome parts of France, it is ſtill employed in bleaching, being ſuppoſed, by its corroſive quality to diſſolve unctuoſities and make the linen white.

From

(*m*) *Starch.*] Common Starch is prepared, by macerating Wheat in water renewed once or twice a day, till it burſts eaſily betwixt the fingers and gives out a kind of white Creme: This, ſqueezed through a canvas bag, and macerated with freſh parcels of water, forms a tenacious fecula; which, after the water is poured off, is taken out in pieces and dried ſlowly in the ſun. A method has lately been diſcovered and communicated in the Swediſh Tranſactions, of making Starch from Potatoes. For this purpoſe, the Potatoes are laid in water twelve hours, then ſkinned, ſoaked again for two hours longer, afterwards ground, moiſtened, preſſed through a hair-ſieve, the pulpy matter boiled with water, ſuffered to ſettle, and treated with freſh parcels of water till the liquor comes off as clear as it was put on: When the laſt water is poured off, the remaining Starch is dried in the ſun, or other very gentle heat. By this proceſs, five pounds of Potatoes yielded eight ounces and three quarters of fine Starch, and one ounce of coarſe. Boiled Potatoes did not ſucceed.

From an ounce of the dry root I obtained ſcarcely a ſcruple of ſpirituous extract: The ſame quantity yielded of watery extract, near three drams. The firſt had ſome ſlight pungency; the latter none. ARUM.

THE fine duſt of LYCOPODIUM or Puffball is called by ſome, on account of its great inflammability, vegetable Sulphur. The Puffball is the ſeed-veſſel of a ſpecies of Moſs named by Tournefort *Muſcus ſquamoſus vulgaris repens clavatus*; and the duſt is properly the ſeeds of the plant. There are ſundry other vegetables, as Polypodies, Ferns, Coniferous trees, *&c.* whoſe ſeeds are a like yellow impalpable Farina, ſo ſubtile as to be blown away by the leaſt motion of air: It is this duſt which has given riſe to ſome reports of ſhowers of Brimſtone. LYCOPODIUM.

The duſt of Lycopodium, diffuſed or ſtrewed in the air, takes fire from a candle, and burns off like a flaſh of lightning, with a conſiderable noiſe: A quantity laid together upon burning coals, does not flame, but ſmokes away, with a fetid ſmell: Burnt in a red-hot crucible, it leaves a very ſmall proportion of a light cobweb-like matter. It does not, as ſome report, take fire from Flint and Steel, nor explode like Gunpowder; nor does it ſeem to detonate more violently with Nitre than other inflammable matters do. Olearius relates, that the Ruſſians employ much of it in fire-works, but does not inform us in what manner.

This ſubſtance, chemically analyſed, appears to contain a reſinous matter, and an oily one of the expreſſible kind, intimately combined together, ſo as to be both extracted, at leaſt in part, by rectified Spirit of Wine: On inſpiſſating the tincture, the Oil ſeparated, remained permanently fluid, and would not unite again even with the reſinous extract: It is remarkable, that pure ſpirit would no longer touch this Reſin any more than the Oil. The quantity thus extracted from an ounce of the powder amounted only to a dram: Water did not take up near ſo much; it was with great difficulty I obtained by water eight grains of extract from an ounce. Both the water and ſpirit aroſe in diſtillation unchanged.

By deſtructive diſtillation in an open fire, I gained a large proportion of empyreumatic Oil, no leſs than two ounces and a half from four: This was preceded, not by an acid liquor, which moſt vegetables yield on the ſame treatment, but by an urinous one; the black Coal remaining in the bottom of the diſtilling veſſel weighed five drams.

AS CORK ſtoppers ſometimes affect the colour or the taſte of liquors, it may be proper to beſtow ſome experiments on this ſubſtance in that view. Cork is the bark of a tree of the Oak kind, growing in France, Italy, Spain, and ſome other parts of Europe: The French Cork is the whiteſt, the Spaniſh the ſofteſt and moſt eſteemed. The bark is taken off every three years, preſſed flat, dried, and then ſcorched on the outſide to preſerve it from inſects. CORK.

Cork boiled in water communicated a browniſh colour, and on evaporating the decoctions, there remained two ſcruples of ſolid extract from an ounce: The reſiduum, digeſted in rectified ſpirit, gave out eleven grains. Spirit applied at firſt extracted two ſcruples and two grains from an ounce, and water afterwards

CORK. afterwards eight grains. The ſpirituous tincture was yellowiſh, paler in colour than the watery, but ſtronger in taſte: From all the ſpirituous tinctures a powdery matter precipitated, of a reddiſh colour from thoſe made at firſt, and of an aſh-grey when the Cork had been previouſly treated with water.

I likewiſe macerated ſmall pieces of Cork in different liquors ſet in a gently warm place: Diſtilled Vinegar and Spirit of Vitriol were tinged the leaſt; Aqua fortis became ſomewhat yellower, and almoſt wholly corroded and diſſolved the Cork; dulcified Spirit of Vitriol, ſolution of common Salt, dulcified Spirit of Nitre, Spirit of Sea-ſalt, Lime-water, and dulcified Spirit of Sea-ſalt, acquired, (in the order they are here enumerated) more and more of a yellowiſh tinge; Syrup of Violets, dulcified Spirit of Sal ammoniac, and Tincture of Tartar, gained a deeper browniſh-yellow; watery Spirit of Sal ammoniac, Oil of Tartar per deliquium, and vinous Spirit of Sal ammoniac with Quick-lime, received the deepeſt reddiſh tincture of all the liquors examined. In ſundry tinctures, which had been paſſed through a filter and appeared perfectly clear, Cork occaſioned a ſenſible turbidneſs and precipitation, particularly Tinctura Tartari, which diſſolves a conſiderable quantity of the Cork. The change of colour of Syrup of Violets is not a little extraordinary.

COTTON. COTTON (*n*), affords not one of thoſe principles on which the foregoing arrangement of vegetables is built. It gives out no gummy or ſaline matter to water,

(*n*) *Cotton.*] In the Swediſh Tranſactions for the year 1747, a method is given of preparing Flax ſo as to reſemble Cotton, in whiteneſs and ſoftneſs, as well as in coherency. For this purpoſe, a little ſea-water is directed to be put into an iron pot or an untinned copper kettle, and a mixture of equal parts of Birch aſhes and Quick-lime ſtrewed upon it: A ſmall bundle of Flax is to be opened and ſpread upon the ſurface, and covered with more of the mixture, and the ſtratification continued till the veſſel is ſufficiently filled. The whole is then to be boiled with ſea-water for ten hours, freſh quantities of water being occaſionally ſupplied, in proportion to the evaporation, that the matter may never become dry. The boiled Flax is to be immediately waſhed in the ſea, by a little at a time, in a baſket, with a ſmooth ſtick: When grown cold enough to be born by the hands, it muſt be well rubbed, waſhed with Sope, laid to bleach, and turned and watered every day. Repetitions of the waſhing with Sope expedite the bleaching; after which, the Flax is to be beat, and again well waſhed: When dry, it is to be worked and carded in the ſame manner as common Cotton, and preſſed betwixt two boards for twice twenty-four hours. It is now fully prepared and fit for uſe: It loſes in this proceſs near one half of its weight, which is abundantly compenſated by the improvement made in its quality.

The filamentous parts of different vegetables have been employed in different countries, for the ſame mechanic uſes as Hemp and Flax among us. Putrefaction deſtroys the pulpy or fleſhy matter, and leaves the tough filaments entire: By curiouſly putrefying the leaf of a plant in water, we obtain the fine flexile fibres, which conſtituted the baſis of the ribs and minute veins, and which now form as it were a ſkeleton of the leaf. Alcaline Lixivia, in ſome degree, produce ſimilar effects to putrefaction.

The Sieur de Flacourt, in his Hiſtory of Madagaſcar, relates, that different kinds of cloth are prepared, in that iſland, from the filaments of the bark of certain trees boiled in ſtrong Ley; that ſome of theſe clothes are very fine, and approach to the ſoftneſs of Silk, but in durability come ſhort of Cotton; that others are coarſer and ſtronger, and laſt thrice as long as Cotton; and that of theſe, the ſails and cordage of his veſſel were made.

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water, no reſinous matter to ſpirit, and no Oil in diſtillation; and ſeems in theſe kinds of experiments, a ſimple vegetable fibre. The force of fire, however, converts it like all other vegetable bodies into diſſimilar parts; and here it is found to be remarkably different from the animal filaments, Wool, Hair, and Silk. It does not, like them, yield a fetid ſmell when burnt in the open air, nor any urinous Salt or Spirit in cloſe veſſels (*o*). Eight ounces of Cotton, diſtilled COTTON.

The ſame author informs us, that the ſtalks of Nettles are uſed for the like purpoſes in his own country, France. And Sir Hans Sloane relates, in one of his letters to Mr. Ray, that he has been informed by ſeveral, that Muſlin and Callico, and moſt of the Indian linens, are made of Nettles.

In ſome of the Swediſh provinces, a ſtrong kind of cloth is ſaid to be prepared from Hop-ſtalks: And in the Tranſactions of the Swediſh Academy for the year 1750, there is an account of an experiment made in conſequence of that report. Of the ſtalks, gathered in autumn, about as much was taken, as equalled in bulk a quantity of Flax, that would have produced a pound after preparation. The ſtalks were put into water, and kept covered therewith during the winter: In March they were taken out, dried in a ſtove, and dreſſed as Flax. The prepared filaments weighed very nearly a pound, and proved fine, ſoft and white: They were ſpun, and woven into ſix ells of fine ſtrong cloth. The author, Mr. Schiſſler, obſerves, that Hop-ſtalks take much longer time to rot than Flax; and that if not fully rotted, the woody part will not ſeparate, and the cloth will neither prove white nor fine.

(*o*) *Difference from Wool*, &c.] Vegetable filaments, and thread or cloth prepared from them, differ remarkably from Wool, Hair, Silk and other animal productions, not only in the principles into which they are reſoluble by fire, but likewiſe in ſome of their more intereſting properties, particularly in their diſpoſition to imbibe colouring matters; ſundry liquors, which give a beautiful and durable dye to thoſe of the animal, giving no ſtain at all to thoſe of the vegetable kingdom.

A ſolution of Copper in Aqua fortis, which had been changed blue by an addition of volatile ſpirit, on being mixed with a little ſolution of Tin, became turbid and greeniſh. Pieces of white Silk and Flannel boiled, without any previous preparation, in this mixture, received a bright deep yellow dye, whilſt pieces of linen, prepared and unprepared, came out as colourleſs as they were put in.

Fiſhing-nets are uſually boiled with Oak bark or other like aſtringents, which render them more laſting. Thoſe made of Flax receive from this decoction a browniſh colour, which by the repeated alternations of water and air, is in a little time diſcharged, whilſt the fine gloſſy brown, communicated by the ſame means to ſilken nets, permanently reſiſts both the air and water, and ſtands as long as the animal filaments themſelves. In like manner the ſtain of Ink, or the black dye from ſolutions of Iron mixed with vegetable aſtringents, proves durable on Silk and Woollen; but from Linen, the aſtringent matter is extracted by waſhing, and only the yellow iron mould remains.

The red decoction of Cochineal, which, heightened with a little ſolution of Tin, gives the fiery ſcarlet dye to Wool or Silk that have been previouſly impregnated with ſolution of Tartar, makes no impreſſion upon Linen or Cotton prepared in the ſame manner. Mr. du Fay informs us, in the Memoirs of the French Academy for the year 1737, that having prepared a mixed cloth whoſe warp was of Wool and the woof of Cotton, and thoroughly blended the two together by fulling, he ſtill found the Cotton to reſiſt the action of the ſcarlet liquor, and the Wool to receive the ſame colour from it as Wool by itſelf, the ſtuff coming out all over marbled, fiery and white.

Many other inſtances of this kind are known too well to the Callico-printer; whoſe grand deſideratum it is, to find means of making Linen receive the ſame colours that Wool does. The phyſical cauſe of the difference is wholly unknown; and indeed of the theory of dyes in general we know

COTTON. distilled in a retort, gave over three ounces and a half of an acidulous, fuliginous, oily Spirit, and about five drams of an empyreumatic Oil: The remaining coal, burnt in a crucible into white ashes, weighed no more than four scruples, from which was obtained a small portion of fixed alcaline Salt.

Cotton is the produce of a middling sized tree, which grows spontaneously in both the Indies: The seeds of the tree are bedded in this soft substance, with an outer shell over it. There are many other plants which bear a downy or cottony matter: But the down is in most of them unfit for being manufactured like Cotton; the fibres being too coarse, or too short, to be spun into fine threads. There is a Cotton-plant in the East-Indies, whose down can be employed only for stuffing beds, and differs from the common Cotton more remarkably in a great degree of inflammability: When it catches fire, it is said to be almost instantaneously and unextinguishably consumed (*n*).

SECT.

know as yet extremely little. Are animal filaments tubular, and the colouring atoms received within them? Are vegetable filaments solid, and the colour deposited on the surface? Or does not their different susceptibility of colour depend rather on the different intrinsic properties of the two? There are many instances of a like diversity, even in the metallic kingdom, where a mechanical difference in texture can scarcely be presumed to be the cause: Thus Silver receives a deep stain from sulphureous or putrid vapours, or the yolk of a boiled egg, which have no effect upon Tin.

(*n*) ADDITIONAL ARTICLES.

THERE are many vegetable substances, besides those above-mentioned, whose constituent principles are, as yet so imperfectly known, that we cannot, with propriety, either refer them to any of the preceding classes, or form any others that shall comprehend them. Such are particularly the coloured flowers, leaves, &c. of plants, considered merely as subjects of colour. And indeed most of the vegetable colours might, perhaps, be properly ranked here; for though the colouring matter seems in many, from its being extracted by Water, to be of the gummy or gummy-resinous kind; yet, as it is procurable also in the form of a lake not at all dissoluble either by Water or by Spirit, (see page 266.) it cannot strictly be looked upon either as resinous or gummy.

FLOWERS.

AMONG the infinite variety of colours, which glow in the flowers of plants, there are very few which have any durability, or whose fugitive beauty can be arrested by art, so as to be applied to any valuable purposes. The only permanent ones are the yellow. The red, the blue, and all the intermediate shades of purples, crimsons, violets, &c. are extremely perishable. Many of these flowers lose their colour on being barely dried; especially if they are dried slowly, as has been usually directed, in a shady and not warm place. The colours of all of them perish, on keeping, even in the closest vessels. The more hastily they are dried, and the more perfectly they are secured from the air, the longer they retain their beauty. The colouring matter, extracted and applied on other bodies, is still more perishable: Oftentimes it is changed or destroyed in the hands of the operator.

BLUE FLOWERS.

THE colour of many blue flowers is extracted by infusion in Water; but there are some, from which Water gains only a reddish or a purplish hue. Of those that have been tried, there is not one which gives any blue tincture to spirituous liquors: Some give no colour at all, and some a reddish one. The juice, pressed out from the fresh flowers, is for the most part blue.

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The blue juices and infusions are changed red by all acids: The marine acid seems to strike the most florid red. The flowers themselves, macerated in acid liquors, impart also a deep red tincture. Alcalies, both fixed and volatile, and Lime-water, change them to a green. Those infusions or juices, which have nothing of the native colour of the flower, suffer the same changes from the addition of acid and alcaline liquors: Even when the flowers have been kept till their colour is lost, infusions made from them acquire still a red colour from the one, and a green from the other, though in a less degree than when the flowers were fresh.

The red colour produced by acids, is scarcely more durable than the original blue: Applied upon other bodies, and exposed to the air, it gradually degenerates into a faint purplish, and at length disappears, leaving hardy any stain behind. The green produced by alcalies, changes to a yellow, which does not fade so soon. The green, by Lime-water, is more permanent and more beautiful: Green lakes, prepared from these flowers by Lime-water, have been used as pigments by the painter.

The flowers of Cyanus have been greatly recommended, as affording elegant and durable blue pigments; but I have never been able to extract from them any blue colour at all. They retain their colour indeed, when hastily dried, longer than some other blue flowers; but they communicate nothing of it to any kind of menstruum. Infusions of them in watery, spirituous, and oily liquors, are all more or less of a reddish cast, without any tendency to blue. Alum, which is said to heighten and preserve their blue colour, changes it, like that of other blue flowers, to a purplish red; acids to a deep red; alcalies and Lime-water to a green. Solution of tin, added to the watery infusion, turns it to a fine crimson: On standing, a beautiful red fecula subsides, but it loses all its colour by the time it is dry. The watery infusion, inspissated to the consistence of an extract, appears of a dark reddish brown: An extract made with rectified Spirit is of a purplish colour. The colour of both extracts, spread thin and exposed to the air, quickly fades——The flowers employed in these experiments were those of the common blue bottle of the cornfields, *Cyanus segetum C. B. Centaurea calycibus serratis: foliolis linearibus integerrimis: infimis dentatis Linn. Spec.* FLOWERS.

RED FLOWERS.

RED flowers readily communicate their own red colour to watery menstrua: Among those that have been tried, there is not one exception. Those of a full red colour, give to rectified Spirit also a deep red tincture, brighter, though somewhat paler, than the watery infusion: But the lighter red flowers, and those which have a tendency to purplish, impart very little colour to Spirit, and seem to partake more of the nature of the blue flowers than of the pure red.

Infusions of red flowers are supposed to be heightened by acids, and turned green by alcalies like those of the blue: But this is far from being universal. Among those I have examined, the rose colours and purplish reds were all changed nearly in the same manner as the blues; but the full deep reds were not. The deep infusion of red Poppies is turned by alcalies not to a green, but to a dusky purple.

YELLOW FLOWERS.

THE colours of yellow flowers, whether pale or deep, are in general durable: Many of them are as much so, perhaps, as any of the native colours of vegetables. The colour is extracted both by Water and by Spirit: The watery infusions are the deepest. Neither acids nor alcalies alter the species of colour, though both of them vary its shade; acids rendering it paler, and alcalies deeper: Alum likewise considerably heightens it, though not so much as alcalies.

Wool or Silk, impregnated with a Solution of Alum and Tartar, receives, on being boiled with the watery infusion or decoction, a durable yellow dye, more or less deep according as the liquor is more or less saturated with the colouring matter. An infusion of the flowers made in alcaline ley, precipitated by Alum, gives a durable yellow lake. Some of these flowers, particularly those of the *Chrysanthemum* or Cornmarigold, appear (from the *Ars tinctoria fundamentalis* published by Stahl) to be made use of by the German dyers.

In

FLOWERS. In ſome of the deep reddiſh yellow or orange-coloured flowers, the yellow matter ſeems to be of the ſame kind with that of the pure yellow flowers, but the red to be of a different kind from the pure red ones: Watery menſtrua take up only the yellow, and leave the red, which may afterwards be extracted by rectified Spirit of Wine, or by Water acuated with fixed alcaline Salt. Such particularly are the ſaffron-coloured flowers of Carthamus. Theſe, after the yellow matter has been extracted by Water, are ſaid to give a red tincture to Ley; from which, on ſtanding at reſt for ſome time, a deep bright red fecula ſubſides; called, from one of the names of the plant which produces it, Safflower; and from the countries whence it is commonly brought to us, Spaniſh-red and China-lake. This pigment impregnates Spirit of Wine with a beautiful red tincture, but communicates no colour to Water.

I have endeavoured to ſeparate, by the ſame treatment, the red matter of ſome of the other reddiſh yellow flowers, as thoſe of the garden Marigold; but without ſucceſs. Plain Water extracted a yellow colour, and alcaline ley extracted afterwards only a paler yellow: Though the digeſtions were continued till the flowers had loſt their colour, the tinctures were no other than yellow, and not ſo deep as thoſe obtained from the pure yellow flowers.

The little yellow floſculi, which in ſome kinds of flowers are collected into a compact round diſc, as in the Daiſy and Corn-marigold, agree, ſo far as they have been examined with the expanded yellow petala. Their colour is affected in the ſame manner by acids, by alcalies, and by Alum; and equally extracted by Water and by Spirit.

But the yellow farina, or fine duſt lodged on the tips of the ſtamina of flowers, appears to be of a different kind. It gives a fine bright yellow to Spirit, and a duller yellow to Water; the undiſſolved part proving in both caſes of a pale yellowiſh white. Both the watery and ſpirituous tinctures were heightened by alcaline liquors, turned red by acids, and again to a deep yellow on adding more of the alcali. I know no other vegetable yellow that is changed red by acids.

WHITE FLOWERS.

WHITE flowers are by no means deſtitute of colouring matter. Alcaline lixivia extract from ſome of them a green tincture, and change their colourleſs expreſſed juices to the ſame colour; but I have not obſerved that they are turned red by acids. The flowers of the common wild Convolvulus or Bindweed, which in all their parts are white, give a deep yellow or orange tincture to plain Water, which like the tinctures of flowers that are naturally of that colour, is rendered paler by acids, heightened a little by Alum, and more conſiderably by alcaline Salts. The vapours of the volatile vitriolic acid, or of burning Sulphur, which whiten or deſtroy the colour of the coloured flowers, make no change in the white.

FRUITS.

THE red juices of Fruits, as red Currants, Mulberries, Elderberries, and Morello and Black Cherries, *&c.* gently inſpiſſated to dryneſs, diſſolve again almoſt totally in Water, and appear nearly of the ſame red colour as at firſt. Rectified Spirit extracts the tinging particles, leaving a conſiderable portion of mucilaginous matter undiſſolved: And hence the ſpirituous tincture proves of a brighter colour than the watery. The red ſolutions, and the juices themſelves, are ſometimes made dull, and ſometimes more florid, by acids; and generally turned purpliſh by alcalies.

The colours of theſe juices are for the moſt part periſhable. They reſiſt indeed the power of fermentation, and continue almoſt unchanged after the liquor has been converted into Wine: But when the juice is ſpread thinly on other bodies, exſiccated, and expoſed to the air, the colour quickly alters and decays: The bright lively reds change the ſooneſt: The dark dull red ſtain from the juice of the Black-cherry is of conſiderable durability. The fruit of the American Opuntia or prickly Pear, the plant upon which the cochineal inſect is produced, is perhaps an exception: This bright red fruit, according to Labat, gives a beautiful red dye. Some experiments however made upon the juice of that fruit, as

brought

brought into England, did not ſeem to promiſe any great advantage from it; but the particulars I cannot now recollect.

The ripe berries of Buckthorn ſtain paper of a green colour. From theſe is prepared the ſubſtance called Sap-green, a pigment ſufficiently durable, readily ſoluble in Water, but not miſcible with Oil. The berries dried whilſt green, and macerated in Alum-water, are ſaid to yield a yellow pigment; and when they have grown overripe, ſo as to fall off ſpontaneouſly, a purple one. Woollen cloth, prepared with Alum and Tartar, receives, on being boiled with the berries, a periſhable yellow dye. The French berries, or *Graine d'Avignon* of the French dyers, one of the moſt falſe, that is the moſt periſhable, of the yellow dyes, is the berry of a ſpecies of Buckthorn, ſmaller than that which grows wild among us.

It is ſaid that the berry of the *Heliotropium tricoccum*, which grows wild about Montpelier, ſtains paper of a green colour, and that this green turns preſently to a blue: That the common blue paper receives its colour from this juice: And that the red rags called *Turnſol*, employed for colouring Wines and other liquors, are tinctured by the ſame juice turned red by acids. According to M. Niſſolle of the French academy of ſciences, (as quoted by Savary in his *Dictionnaire de commerce*,) the colouring juice is obtained, not from the berries, but from the tops of the plant, gathered in Auguſt, ground in mills, and then committed to the preſs. The juice is expoſed to the ſun about an hour, the rags dipt in it, dried in the ſun, moiſtened by the vapour which ariſes during the ſlaking of Quick-lime with Urine, then dried again in the ſun, and dipt again in the juice. The Dutch and others are ſaid to prepare turnſol rags, and turnſol in the maſs, from different ingredients, among which Archil is a principal one.

In ſome plants, Peony for inſtance, the ſeeds, at a certain point of maturity, are covered with a fine ſhining red membrane: The Pellicles of the ſeeds of a certain American tree afford the red maſſes brought into Europe under the names of Annotto, Orlean, and Roucou. The red ſeeds, cleared from the pods, are ſteeped in Water for ſeven or eight days or longer, till the liquor begins to ferment; then ſtrongly ſtirred, and ſtamped with wooden paddles and beaters, to promote the ſeparation of the red ſkins: This proceſs is repeated ſeveral times till the ſeeds are left white. The liquor, paſſed through cloſe cane ſieves, is pretty thick, of a deep red colour, and a very ill ſmell: In boiling, it throws up its colouring matter to the ſurface in form of ſcum, which is afterwards boiled down by itſelf to a due conſiſtence, and made up while ſoft into balls.

The Annotto, commonly met with among us, is moderately hard and dry, of a brown colour on the outſide, and a dull red within. It is difficultly acted upon by Water, and tinges the liquor only of a pale browniſh yellow colour. In rectified Spirit of Wine, it very readily diſſolves, and communicates a high orange or yellowiſh red: Hence it is uſed as an ingredient in varniſhes, for giving more or leſs of an orange caſt to the ſimple yellows. Alcaline Salts render it perfectly ſoluble in boiling Water, without altering its colour: Wool or Silk, boiled in the ſolution, acquire a deep, but not a very durable, orange dye. Its colour is not changed by Alum or by acids, any more than by alcalies; but when imbibed in cloth, it is diſcharged by Sope, and deſtroyed by expoſure to the air.

Mr. Pott, in the Berlin Memoirs for the year 1752, mentions a very extraordinary property of this concrete: "With the vitriolic acid, it produces a *blue* colour, of "extreme beauty, but with this capital de"fect, that all Salts and Liquors, even "common Water, deſtroy it." The ſpecimen of Annotto which I examined was not ſenſibly acted on by Spirit of Vitriol: It received no change in its own colour, and communicated none to the liquor. Nor did any viſible change enſue, upon dropping the acid into tinctures of Annotto made in Water or in Spirit.

Labat informs us, that the Indians prepare an Annotto greatly ſuperior to that which is brought to us; of a bright ſhining red colour, almoſt equal to carmine: That for this purpoſe, inſtead of ſteeping and fermenting the ſeeds in Water, they rub them with the hands, previouſly dipt in Oil, till the pellicles come off and are reduced into a clear paſte, which is ſcraped off from the hands with a knife, and laid on a clean leaf, in the ſhade, to dry. De Lact, in his notes

FRUITS. on Marcgrave's natural hiſtory of Brazil, mentions alſo two kinds of Annotto; one of a permanent crimſon colour, (*Coccineus*) uſed as a fucus; and another, which gives a colour inclining more to that of Saffron. This laſt, which is our Annotto, he ſuppoſes to be a mixture of the firſt ſort with certain reſinous matters, and with the juice of the root of the tree——Ximenes relates, that Annotto with urine ſtains linen of ſuch a permanent colour, that it is never to be waſhed out. Perhaps the firſt ſort is meant. Our Annotto, boiled in urine, imparted to linen a deep yellowiſh red: The ſtained linen, hung out in the air in ſummer, in ſeven or eight days loſt all its colour and became white again.

LEAVES.

THE green colour of the leaves of plants is extracted by rectified Spirit of Wine and by Oils. The ſpirituous tinctures are generally of a fine deep green, even when the leaves themſelves are dull coloured or yellowiſh or hoary. The colour, however, ſeldom abides long even in the liquor; much leſs when the tinging matter is ſeparated in a ſolid form, and expoſed with a large ſurface to the air. The editor of the Wirtemberg Pharmacopæia obſerves, that the leaves of *Acanthus*, Brankurſine or Bears-breech, give a more durable green tincture to Spirit than thoſe of any other herb. Alcalies heighten the colour both of the tinctures and green juices: Acids weaken, deſtroy, or change it to a browniſh. Lime-water improves both the colour and durability: By means of Lime, not inelegant green lakes are procurable from the leaves of Acanthus, Lily of the valley, and ſeveral other plants.

There are very few herbs which communicate any ſhare of their green colour to Water; perhaps none that give a green of any conſiderable deepneſs. It is ſaid, however, that the leaves of ſome plants give a green dye to woollen, without the addition of any other colouring matter; particularly thoſe of the wild Chervil or Cow-weed, (*Myrrhis ſylveſtris ſeminibus lævibus C. B.*) the common Ragwort, and Devils-bit. The proceſs with this laſt, as deſcribed by Linnæus (in the *Svenſka acad. handl. ärs*, 1742.) is pretty remarkable. The peaſants, he informs us, in ſome of the Swediſh provinces, ſtratify the freſh leaves with woollen yarn, and boil them about as long as it is cuſtomary to boil fiſh. The whole is ſuffered to ſtand in the veſſel for a night: The wool, taken out in the morning, does not appear to have received any colour. The pot is again made hot, and the yarn hung over it, upon a ſtick, covered with an inverted diſh to confine the ſteam, for this *ſteam* is ſuppoſed to be eſſential to the colour. The yarn is afterwards wrung, the leaves taken out of the boiling liquor, a little freſh Water added to the decoction, and the wool frequently dipt therein, till it appears ſufficienty coloured.

The leaves of many kinds of herbs and trees give a yellow dye, to wool or woollen cloth that has been previouſly boiled with a ſolution of Alum and Tartar: Weld in particular affords a fine yellow, and is commonly made uſe of for this purpoſe by the dyers, and cultivated in large quantity in ſome parts of England. There is no colour for which we have ſuch plenty of materials as for yellow. Mr. Hellot obſerves, in his *Art de teindre*, that all leaves, barks, and roots, which on being chewed diſcover a ſlight aſtringency, as the leaves of the Almond, Peach and Pear-trees, Aſh bark, (eſpecially that taken off after the firſt riſing of the ſap in ſpring) the roots of wild Patience, *&c.* yield durable yellows, more or leſs beautiful according to the length of time that the boiling is continued, and the proportions of Alum and Tartar in the preparatory liquor: That a large quantity of Alum makes theſe yellows approach to the elegant yellow of Weld: That if the Tartar is made to prevail, it inclines them to an orange: That if the roots, barks or leaves be too long boiled, the yellow proves tarniſhed, and acquires ſhades of brown: That for dying with Weld, the beſt proportions of the Salts are, four parts of Alum, and one of Tartar, to ſixteen of the wool; and that the wool, prepared with theſe, is to be boiled again with five or ſix times its quantity of Weld: That for light ſhades, it is cuſtomary to diminiſh the Alum, and omit the Tartar; and that in this caſe, the colour is more ſlowly imbibed, and proves leſs durable.

Of

Of all the colours of the dyer, we have the feweſt materials for blue. The mineral and animal kingdoms afford none; excepting perhaps Pruſſian blue, which Mr. Macquer has lately attempted to introduce into this art (ſee page 73.) The vegetable yields but two, which are both produced from the leaves of plants, indigo and woad.

INDIGO.

INDIGO, one of the capital manufactures of America, is prepared from a ſmall, fleſhy, ſoft leaf, of a greeniſh brown colour on the upper-ſide, pale and as it were ſilver-coloured underneath. The plant, called *Anil* or *Nil*, has ſeveral ſlender knotty ſtalks, which ſpread into ſmall branches, clothed each with from four to ten pair of theſe leaves and an odd one at the end: It riſes to the height of about two feet, and produces reddiſh flowers, in ſhape reſembling thoſe of broom, but ſmaller, followed by oblong pods, containing the ſeeds.

Labat has given a particular account of the culture of the plant, and the preparation of the Indigo---The ground being thoroughly cleared from weeds (one of the principal points in the culture) a number of ſlaves, ranged in a line, march acroſs, making little trenches of the width of their hoes and two or three inches deep, about a foot diſtant from one another every way: Then, returning, they drop ſome ſeeds in each trench, and afterwards cover them with the earth taken out. In moiſt weather, the plant comes up in three or four days; and in about two months after, it is fit for cutting: If ſuffered to ſtand till it runs into flower, the leaves become too dry and hard, and the Indigo obtained from them proves leſs in quantity, and leſs beautiful: The due point of maturity is known, by the leaves beginning to grow leſs ſupple, or more brittle. In rainy ſeaſons, the cutting may be repeated every ſix weeks: Cutting in dry weather kills the plant, which, if that is avoided, continues to afford freſh crops for two years.

A large quantity of the herb is put into a vat or ciſtern of ſtrong maſon work, with ſo much Water as is ſufficient to cover it; and ſome wood laid above, to prevent its riſing up. The matter begins to ferment, ſooner or later according to the warmth of the weather and the maturity of the plant, ſometimes in ſix or eight hours, and ſometimes not in leſs than twenty. The liquor grows hot, throws up a plentiful froth, thickens by degrees, and acquires a blue colour inclining to violet. At this time, without touching the herb, the liquor impregnated with its tincture is let out, by cocks in the bottom, into another vat placed for that purpoſe ſo as to be commanded by the firſt. INDIGO.

In the ſecond vat, the liquor is ſtrongly and inceſſantly beat and agitated, with a kind of buckets fixed to poles, till the colouring matter is united into a body. A good deal of nicety is requiſite in hitting this point: If the beating is ceaſed too ſoon, a part of the tinging matter remains diſſolved in the liquor; if continued a little too long, a part of that which had ſeparated is diſſolved afreſh. The exact time for diſcontinuing the proceſs is determined, by taking up ſome of the liquor occaſionally in a little cup, and obſerving whether the blue fecula is diſpoſed to ſeparate and ſubſide.

The whole being now ſuffered to reſt till the blue matter has ſettled, the clear Water is let off, by cocks in the ſides at different heights; and the blue part diſcharged by a cock in the bottom, into another vat. Here it is ſuffered to ſettle for ſome time longer, then further drained in cloth bags, and expoſed in ſhallow wooden boxes to the air till thoroughly dry.

The author above-mentioned, from whom the whole of the foregoing account is extracted, obſerves further, that the goodneſs of the Indigo depends greatly upon the age of the plant; that before it has grown fully ripe, the quantity it yields is leſs, but the colour proportionably more beautiful; that probably the ſecret of thoſe, whoſe Indigo has been moſt eſteemed, is no other than cutting the herb at the time when it yields the fineſt colour; that the ſuperiority of ſome of the Indigoes of the Eaſt-Indies to thoſe of America, is perhaps owing to the former being prepared more curiouſly from only the leaves of the plant; and that by beating the herb in the ſteeping-vat, which has been practiſed by ſome with a view to increaſe the quantity, great part of the ſubſtance of the leaves and bark is blended with the Water along with the colouring

INDIGO. ing matter, and the Indigo extremely debaſed.

It is ſaid that Lime or Lime-water is ſometimes employed in the beating-vat, to promote the ſeparation of the tinging particles from the Water; and that the hardneſs or flintineſs of ſome ſorts of Indigo is owing to an over proportion of this addition.

Indigo is commonly divided, from the colour which it exhibits upon breaking, into three kinds, copper-coloured, purple, and blue: It is ſaid that the dyers uſe chiefly the firſt; and the callico-printers (for this drug gives a durable ſtain to linen as well as woollen) the laſt. On what particular circumſtances theſe different appearances depend, we know not; nor is it certainly known, whether the real quality of the Indigo has any connexion with them. The deepeſt and livelieſt blue Indigo, rubbed with the nail, looks like poliſhed Copper; and ſolutions of all the ſorts, made in alcaline lixivia, aſſume alike a copper-coloured ſkin upon the ſurface.

Good Indigo is moderately light, breaks of a ſhining ſurface, and burns almoſt wholly away upon a red hot iron. It is quickly penetrated by Water, and reduced into a kind of paſte: A conſiderable part is at the ſame time diffuſed through the liquor, and very ſlowly ſubſides: This is probably what Labat and Hellot mean by its diſſolving in Water, for no part of the Indigo really diſſolves; it cannot indeed be expected that it ſhould, from the proceſs by which it is obtained.

Indigo requires an equal quantity or more of fixed alcaline Salt, to render it totally ſoluble in Water. On digeſting the Indigo, with a gentle heat, in the ſolution of the alcaline Salt, a ſhining copper-coloured ſkin begins to appear, and gradually covers the whole ſurface: On agitating the matter, a large blue flower or froth ariſes, and the liquor underneath appears of a deep green. If woollen cloth, without any other preparation than moiſtening it with warm Water, be dipt in this hot liquor, it comes out perfectly green, and changes almoſt inſtantly in the air to a fine blue. This is the common proceſs of dying blue.

Mr. Hellot deſcribes two Indigo vats with urine; one of which is uſed hot like the foregoing, and the other cold. The hot vat conſiſts of equal parts of Indigo, Alum, and Tartar, digeſted in urine till the liquor becomes green. The cold one is prepared, by digeſting powdered Indigo with Vinegar for twenty-four hours, in the proportion of four pounds to about three quarts; then mixing the matter with about fifty gallons of urine, and ſtirring the whole together every night and morning, till the liquor turns green, and gathers a head like the common vat.

Indigo is fitted for printing on linen, by diluting it with Water into the conſiſtence of a ſyrup; then adding ſome powdered Pearl-aſhes, green Vitriol, and Lime newly ſlaked; with ſo much Water, occaſionally, as will reduce them into the conſiſtence of thin paint; mixing the whole thoroughly together, and ſtirring the matter every now and then, till it gains a copper colour on the ſurface. The proportions uſed by the workmen are, two parts of Indigo, one of Pearl-aſhes, three of Vitriol, and two of Lime.

The ſame compoſition, diluted with a ſufficient quantity of Water (about ſix gallons to a pound of Indigo) and boiled, gives a durable blue to tanned ſkins, whether dipt in it hot or cold.

Indigo, digeſted in a moderate heat with different volatile alcaline ſpirits, gave only yelloviſh and browniſh red tinctures; with rectified Spirit of Wine, a reddiſh one: To Lime-water, and to Water acidulated with the vitriolic, nitrous and marine acids, it gave no tincture at all.

The concentrated vitriolic acid unites with it into a ſmooth paſte, eſpecially if the Indigo is previouſly well ground with powdered glaſs, ſand, or other like ſubſtances: The Indigo is thus rendered ſoluble in boiling Water along with the acid, ſo as to paſs through the pores of a filter: The ſolution, whilſt hot, appears of a deep bright green colour, like that made by fixed alcalies, but fades as it grows cold, and changes at laſt to a browniſh.

Theſe experiments, which were many times repeated with the ſame event, ſeem to overturn Mr. Hellot's ingenious theory; which deduces the green colour of ſolutions of Indigo from the common property of blue juices of being turned green by alcalies; and the blue colour which the cloth acquires ſoon after it is taken out of the vat, from

from a ſeparation of the alcali. We here find, that a green ſolution of this concrete is obtainable by the ſtrongeſt of the acids, and that with volatile alcalies it diſcovers no tendency to greenneſs.

The ſolution of Indigo in Oil of Vitriol does not appear green till boiled. The thick compound, dropt into Water no hotter than the hand can bear, communicates a bright blue colour: Woollen cloth or ſilk, prepared with Alum and Tartar, acquire from this liquor the beautiful but periſhable blue dye called Saxon blue. The Saxon green is dyed, by dipping the ſtuff a ſecond time in the yellow decoction of Fuſtick; or more compendiouſly, by mixing the acid blue compoſition with that decoction at once, till the liquor has gained the depth of colour required.

I have been informed that the dyers of Norwich, who purchaſed this ſecret from Saxony, prepare the blue compoſition by grinding nine parts of Indigo with twenty of red Arſenic; then adding to them, in a glazed veſſel, forty-eight parts of Oil of Vitriol, and ſtirring them well together: After the mixture has ſtood for twenty-four hours, it is fit for uſe. In Mr. Hellot's proceſs, received likewiſe from Germany, the proportions are ſomewhat different; and inſtead of red Arſenic, Cobalt and Orpiment are uſed. Theſe differences are immaterial: The only uſe of the additional matter ſeems to be, to divide the Indigo, and render it more eaſily miſcible with the acid. I have ſucceeded, in ſmall ſpecimens, with red and with white Arſenic, with Orpiment and with Cobalt, with Sulphur, with Antimony, with powdered Glaſs, with powdered Sand, and with Flint.

The Indigo, in the diluted blue liquors, is perfectly diſſolved, ſo as to paſs through a filter. The ſolutions, haſtily evaporated to the conſiſtence of a Syrup, become turbid and green. On ſlow evaporation, they continued uniform and blue, and readily mingled again with freſh water, paſſing the filter as before of a fine blue colour.

WOAD.

WOAD, *Iſatis*, *Glaſtum*, is a plant with long green leaves; the lower ones narrow at both ends; thoſe which grow upon the ſtalk broad at bottom like an arrow head. On the tops come forth numerous yellow flowers, which are followed by little flat pods containing the ſeeds. It grows wild in ſome parts of France, and on the coaſts of the Baltic ſea: The wild Woad, and that which is cultivated for the uſe of the dyers, appear to be the ſame ſpecies of plant. WOAD.

The preparation of Woad for dying, as practiſed in France, is minutely deſcribed by Aſtruc, in his memoirs for a Natural Hiſtory of Languedoc----The plant puts forth at firſt five or ſix upright leaves, about a foot long and ſix inches broad: When theſe hang downwards, and turn yellow, they are fit for gathering: Five crops are gathered in one year. The leaves are carried directly to a mill, much reſembling the oil or tan-mills, and ground into a ſmooth paſte. If this proceſs was deferred for ſome time, they would putreſy, and ſend forth an inſupportable ſtench. The paſte is laid in heaps, preſſed cloſe and ſmooth, and the blackiſh cruſt, which forms on the outſide, reunited if it happens to crack: If this was neglected, little worms would be produced in the cracks, and the Woad would loſe of its ſtrength. After lying for fifteen days, the heaps are opened, the cruſt rubbed and mixed with the inſide, the matter formed into oval balls, which are preſſed cloſe and ſolid in wooden moulds. Theſe are dried upon hurdles: In the ſun, they turn black on the outſide; in a cloſe place, yelloviſh, eſpecially if the weather is rainy: The dealers in this commodity prefer the firſt, though it is ſaid the workmen find no conſiderable difference betwixt the two. The good balls are diſtinguiſhed by their being weighty, of a pretty agreeable ſmell, and when rubbed, of a violet colour within—For the uſe of the dyer, theſe balls require a further preparation: They are beat with wooden mallets, on a brick or ſtone floor, into a groſs powder; which is heaped up in the middle of the room to the height of four feet, a ſpace being left for paſſing round the ſides. The powder, moiſtened with water, ferments, grows hot, and throws out a thick fetid ſume. It is ſhovelled backwards and forwards, and moiſtened every day for twelve days; after which, it is ſtirred leſs frequently, without watering, and at length made into a heap for the dyer.

The powder thus prepared, gives only browniſh

WOAD. browniſh tinctures, of different ſhades, to water, to rectified Spirit of Wine, to volatile alcaline ſpirits, and to fixed alcaline Lixivia: Rubbed on paper, it communicates a green ſtain. On diluting the powder with boiling water, and after ſtanding for ſome hours in a cloſe veſſel, adding about one twentieth its weight of Lime newly ſlaked, digeſting in a gentle warmth, and ſtirring the whole together every three or four hours, a new fermentation begins, a blue froth ariſes to the ſurface, and the liquor, though it appears itſelf of a reddiſh colour, dyes woollen of a green, which, like the green from Indigo, changes in the air to a blue. This is one of the niceſt proceſſes in the art of dying, and does not well ſucceed in the way of a ſmall experiment.

Aſtruc propoſes the manufacturing of freſh Woad leaves in Europe, after the ſame manner as the Indigo plant is manufactured in America; and thus preparing from it a blue fecula ſimilar to Indigo, which from his own experiments he has found to be practicable. Such a management would doubtleſs be accompanied with ſome advantages, though poſſibly, Woad ſo prepared might loſe thoſe qualities which now render it, in a large buſineſs, preferable on ſome accounts to Indigo, as occaſioning greater diſpatch when once the vat is ready, and giving out its colour leſs haſtily, ſo as to be better fitted for dying very light ſhades.

Hellot ſuſpects, that a like blue fecula is procurable from many other vegetables. Blue and yellow, blended together, compoſe a green: He ſuppoſes the natural greens of vegetables to be compounded in like manner of thoſe two colours; and that the blue is oftentimes the moſt permanent, ſo as to remain entire after the putrefaction or deſtruction of the yellow. The theory is ſpecious, and perhaps juſt: We know of no other that accounts, in any degree, for the production of the Indigo and Woad blue. In the experiments, however, which I have made, of putrefying different herbs in water, the blue and the yellow colour, if the green was really compoſed of theſe, were both deſtroyed together, no appearance being obſerved either of one or the other during the whole proceſs.

MOSSES.

THERE are ſundry Moſſes, which in their natural ſtate, like the two foregoing plants, promiſe nothing of the elegant colours, which art calls forth from them.

Archil, *Archilla*, *Rocella*, *Orſeille*, a whitiſh Moſs growing upon rocks in the Canary and Cape Verd iſlands, yields a rich purple tincture, fugitive indeed, but extremely beautiful. This weed is imported to us as it is gathered: Thoſe who prepare it for the uſe of the dyer, grind it betwixt ſtones, ſo as to thoroughly bruiſe but not reduce it into powder, and then moiſten it occaſionally with a ſtrong Spirit of Urine, or Urine itſelf mixed with Quick-lime: In a few days it acquires a purpliſh red, and at length a blue colour: In the firſt ſtate it is called Archil, in the latter Lacmus or Litmaſe.

The dyers rarely employ this drug by itſelf, on account of its dearneſs and the periſhableneſs of its beauty. The chief uſe they make of it is, for giving a bloom to other colours, as pinks, *&c.* This is effected by paſſing the dyed Cloth or Silk through hot water lightly impregnated with the Archil. The bloom thus communicated ſoon decays upon expoſure to the air. Mr. Hellot informs us, that by the addition of a little ſolution of Tin, this drug gives a durable dye; that its colour is at the ſame time changed towards a ſcarlet; and that it is the more permanent, in proportion as it recedes the more from its natural colour.

Prepared Archil very readily gives out its colour to water, to volatile ſpirits, and to Spirit of Wine: It is the ſubſtance principally made uſe of for colouring the ſpirits of thermometers. As expoſure to the air deſtroys its colour upon cloth, the excluſion of the air produces a like effect in theſe hermetically ſealed tubes; the ſpirits of large thermometers becoming in the compaſs of a few years colourleſs. M. l'Abbè Nollet obſerves (in the French Memoirs for the year 1742) that the colourleſs ſpirit, upon breaking the tube, ſoon reſumes its colour, and this for a number of times ſucceſſively; that a watery tincture of Archil, included in the tubes of thermometers, loſt its colour in three days; and that in an open deep veſſel, it became colourleſs at the bottom, whilſt the upper part retained its colour.

A ſo-

A ſolution of Archil in water, applied on cold Marble, ſtains it of a beautiful violet or purpliſh-blue colour, far more durable than the colour which it communicates to other bodies. Mr. du Fay ſays he has ſeen pieces of Marble ſtained with it, which in two years had ſuffered no ſenſible change. It ſinks deep into the Marble, ſometimes above an inch; and at the ſame time ſpreads upon the ſurface, unleſs the edges be bounded by Wax or other like ſubſtances. It ſeems to make the Marble ſomewhat more brittle.

Linnæus informs us, in the Swediſh Tranſactions for the year 1742, that the true Archel Moſs is to be found on the weſtern coaſts of England; and ſuſpects, that there are ſeveral other more common Moſſes, from which valuable colours might be extracted: A quantity of Sea-moſs having rotted in heaps upon the ſhore, he obſerved the liquor in the heaps to look like blood, the ſea-water, and the ſun, and the putrefaction having brought out the colour. Mr. Kalm, in an appendix to Linnæus's paper in the year 1745, mentions two ſorts of Moſſes actually employed in ſome parts of Sweden for dying woollen red: One is the *Lichenoides coralliforme apicibus coccineis* of Ray's Synopſis; the other, the *Lichenoides tartareum farinaceum, ſcutellarum umbone fuſco* of Dillenius. This laſt is a white ſubſtance, like meal clotted together, found on the ſides and tops of hills. It is ſhaved off from the rocks after rain, purified from the ſtony matters intermixed among it by waſhing with water, then dried in the ſun, ground in mills, and again waſhed and dried: It is then put into a veſſel with Urine, and ſet by for a month: A little of this tincture added to boiling water makes the dying liquor---In the ſame Tranſactions, for the year 1754, there is an account of another Moſs, which prepared with Urine, gives a beautiful and durable red or violet dye to Wool and Silk. This is the *Lichen foliaceus, umbilicatus, ſubtus lacunoſus Linn. flor. ſuec.* It grows upon rocks, and is readily diſtinguiſhed from others of that claſs, by its looking as if burnt or parched, conſiſting of leaves as thin as paper, convex all over on the upper ſide, with correſponding cavities underneath, adhering firmly to the ſtones by a little root under the leaves, and coming aſunder, when dry, as ſoon as touched. It is gathered after rain, as it then holds beſt together, and parts eaſieſt from the ſtone. MOSSES.

In France, a cruſtaceous Moſs, growing upon rocks in Auvergne, is prepared with Lime and Urine, and employed by the dyers as a ſuccedaneum to the Canary Archil, to which it is ſaid to be very little inferior: It is called *Orſeille d'Auvergne* or *Perelle*. Mr. Hellot relates, that he has met with ſeveral other Moſſes, which on being prepared in the ſame manner acquire the ſame colour. The moſt expeditious way, he ſays, of trying whether any Moſs will yield an Archil or not, is, to moiſten a little of it with a mixture of equal parts of Spirit of Sal ammoniac and ſtrong Lime-water, and add a ſmall proportion of crude Sal ammoniac: The glaſs is then to be tied over with a piece of bladder, and ſet by for three or four days. If the Moſs is of the proper kind, the little liquor, which runs from it upon inclining the veſſel, will appear of a deep crimſon colour; and this afterwards evaporating, the plant itſelf acquires the ſame colour.

I have tried a good number of the common Moſſes, both of the cruſtaceous and foliaceous kind, and not a few of the fungi; as alſo the herbs Camomile and Milfoil which yield a blue eſſential Oil, and Thyme whoſe Oil becomes blue by digeſtion with volatile ſpirits; but have not as yet met with any that yielded a colour like Archil. Moſt of them gave a yellow or reddiſh-brown tincture; and if there was a ſcarcity of other drugs for theſe kinds of dyes, ſome of the Moſſes might be made to afford not inelegant ones. A few gave a deep red colour to the liquor; but when diluted it ſhewed a yellowiſh caſt, and when applied on cloth it gave only a yellowiſh red.

SECT.

SECT. IV.

Artificial productions from VEGETABLES.

ARTIFICIAL PRODUCTS.

IN the foregoing ſections we have endeavoured to inveſtigate the internal conſtitution of vegetables in their natural ſtate, by operations which do not alter their qualities; to diſcover, extract, and preſerve thoſe principles which actually exiſt in them, and in which their ſpecific powers reſide. It has formerly been obſerved, that theſe principles are far from being elementary bodies. By fermentation, and by the force of fire, the Gums, the Reſins, the Oils, and the Salts of vegetables, are reſolved or converted into more ſimple parts, and ſome of theſe combined variouſly together again into new compounds: The taſte, the ſmell, the colour of the original vegetable are deſtroyed, and ſubſtances of entirely different qualities are produced.

CLASS I.

Products from Vegetables by Fermentation.

FERMENTATION.

SWEET vegetable juices or infuſions made in water, however bright pellucid and apparently homogene, on being kept in a temperately warm place in veſſels not cloſely ſtopt, become turbid, conceive an inteſtine motion, emit numerous air bubbles, and diſcharge a pungent vapour of extreme ſubtility and activity, inſomuch as, when confined and accumulated in cloſe rooms, to extinguiſh fire and ſuffocate animals: Its producing the firſt of theſe effects, is a mark that it is collected in ſufficient quantity to produce the other: When candles continue to burn, we need not be afraid that this wild Gas, as Helmont calls it, will be dangerous to life. As the fermentation advances, a large quantity of groſs, unctuous, ſaline and earthy matter is ſeparated and thrown off, partly to the ſurface, and partly to the bottom of the veſſel: The liquor loſes its ſweet taſte and acquires a vinous one, and on being now committed to diſtillation yields, not as at firſt a mere watery phlegm, but an inflammable inebriating ſpirit——On continuing the fermentation beyond the ſtate of vinoſity, more matter is thrown off, new combinations take place, the inflammable ſpirit is deſtroyed, and the liquor becomes ſour——If the proceſs be ſtill further protracted, the acid ſtate is ſucceeded by a putrefactive one; during which a volatile alcaline Salt is both generated and diſſipated: The ſolid matter that now remains is an earth ſimilar to common mould; and if any fluid is left, it is found to be an inſipid water.

Vinous.

Acetous.

Putrefactive.

Obſervations on its three ſtages.

Fermentation is hence divided, according to its effect, into three ſtages or degrees, vinous, acetous, and putrefactive: The product of the firſt is an inflammable ſpirit, and of the ſecond an acid, both of which are peculiar to the vegetable

vegetable kingdom: The volatile alcali, produced by the third ſtage, is ſimilar to that obtained, more plentifully, from animal ſubſtances by the action of fire without putrefaction. The putrefactive ſtage always follows the vinous and acetous, unleſs prevented by art, but it is not always preceded by them, all vegetables being ſuſceptible of putrefaction, whilſt thoſe only that have a manifeſt ſweetneſs are capable of yielding a vinous liquor. The ſweeter and richer the vegetable juice, the longer does the vinous fermentation continue, and the ſtronger and more ſpirituous is the Wine: The more acid alſo is the Vinegar. FERMENTATION.

Is is obſervable that when ſweet juices are boiled down to a thick conſiſtence, they not only do not ferment in that ſtate, but are not eaſily brought into fermentation when diluted with as much water as they had loſt in the evaporation, or even with the very individual water that had exhaled from them. Juices and decoctions in general, that have ſuffered much fire, however ſweet, are little diſpoſed to ferment. Hence ſundry ſweet liquors, naturally very propenſe to run into this proceſs, and to run haſtily through all its ſtages, are preſerved for a length of time by being boiled. Impeded and promoted.

The head which forms on the ſurface of fermenting liquors greatly haſtens the fermentation of others, and determines them to the ſame ſpecies of fermentation with that of the liquor from which the ferment was taken. The grand promoters of all the ſtages of this proceſs are, warmth, a moderate admiſſion of air, and the addition of matters in an actually fermentative ſtate. When the vinous ſtage is completed, the acetous would ſoon begin, if the liquor was not racked into freſh veſſels, ſecured from the air, and kept in a cold place.

I. WINES.

THE juices of ſweet fruits in general, Currants, Mulberries, Raſpberries, Apples, Pears, &c. are called, when fermented, Wines; but the name is more peculiarly applied to the fermented juice of the Grape or the fruit of the Vine-tree. WINES.

There is a great variety of Grapes, colourleſs, yelloviſh, bluiſh, and red; more or leſs ſweet, and of more or leſs flavour. The colour is lodged not in the juice but in the ſkin of the Grape: The juice however, as a menſtruum, frequently extracts and becomes impregnated with it during its expreſſion from the fruit.

One and the ſame kind of Grape proves greatly different in taſte and flavour, according to the climate and expoſure to the ſun. In cold countries the Vine, if it grows at all, never ripens its fruit; and even in France and Italy I have obſerved, that the Grapes produced on the South-ſides of hills are notably ſweeter than thoſe which grow on plane grounds. Among the Tockay Wine-hills, there is but one which directly fronts the South, and the advantages of its ſituation are not a little remarkable: From the extraordinary ſweetneſs of its Grapes, it is called the Sugar-hill. It affords the moſt delicious of all the Hungarian Wines, and is appropriated to the uſe of the imperial family. Differences in Grapes from climate, &c.

WINES. In very warm dry ſeaſons, the Grapes at the bottoms of the hills are beſt; in warm and moiſt ones, thoſe at the top; ſuch as grow in the middle region being always good. In dry ſummers, the Grapes are ſweeteſt, but leaſt juicy: In rainy ones they abound with juice, which proves proportionably weaker and more dilute. Froſts in autumn promote their ripening; but froſt ſucceeding heavy rains make them apt to burſt and ſhed their juice.

In ſome places, the Grape is concentrated or rendered richer, by ſuffering it to remain on the tree till great part of its watery moiſture has exhaled, the ſtem of each cluſter being cut half through, when the fruit is ripe, to prevent the afflux of any freſh juice from the plant. The ſweet Hungarian and Spaniſh Wines are made from Grapes that have thus been half dried. The Raiſins, and Currants of the ſhops, are different ſpecies of Grapes, dried either in this manner, or by the ſolar or culinary heat after gathering.

Muſt, its differences; The juice of the Grape is called, before its fermentation, Muſt. Different ſorts of Muſt are obtained from the ſame kind of Grape, produced in the ſame vineyard, according to the method of management. The beſt is that which iſſues upon breaking, bruiſing, or treading the picked fruit: Inferior ſorts are extracted by forcibly preſſing the entire cluſter, ſtalks and all. Dilute watery Muſts are enriched by infuſing in them dried Grapes, or by inſpiſſating a part of the liquor and adding this to the reſt. By theſe means ſtrong full-bodied Wines are obtainable from the pooreſt juices; and by ſimilar managements even the better ſorts of Grape-wines are imitable with the juices of other fruits, artificially concentrated, or heightened with the ſimple ſweetneſs of Sugar.

enriched.

Arrangement of Wines according to their production. Wine may be divided, with reſpect to the fermentation, into three claſſes. (1.) Thoſe of the firſt do not indeed deſerve the name of Wines, as having ſcarcely ſuffered any degree of fermentation at all, and being no other than boiled Muſt. Several of the Italian Wines are of this ſort, and are called by the general name of *Vino cotto* or boiled Wine. It is to thin watery juices, extremely prone to ferment, and in which fermentation, when once begun, can ſcarcely be ſuppreſſed till it has run beyond the vinous ſtate, that this proceſs is applied: By boiling, the fermentative quality is reſtrained, and the liquor becomes richer and continues fit for drinking for at leaſt a year or two, though it is never ſo wholſome as the fermented Wines. The effects of Muſt and Wine upon animal bodies are diametrically different: Muſt relaxes and liquefies, and if drank immoderately, is apt to produce dangerous fluxes: Perfect Wine, on the contrary, corroborates and conſtringes. (2.) The ſecond claſs comprehends thoſe Wines, which have undergone fermentation, but not a complete one: Of theſe there are two kinds. The firſt is the thin ſweet Wines; which are no other than Muſt partially fermented, or whoſe fermentation is checked, while it can be checked, before the ſweetneſs has gone off: Theſe Wines can ſcarcely be kept above a year: Such are the Tyrol, ſome of the Savoy, and ſeveral of the Italian. The ſecond ſort is the ſtrong, full-bodied, rich, ſweet Wines, which are generally a mixture of fermented and inſpiſſated Muſt; the latter being added to increaſe the richneſs of the liquor, and prevent the fermentation from running beyond its due limits: Theſe kinds of Wines greatly heat the conſtitution, and ought to be very ſparingly drank: Such are Malmſey, Canary, and ſome of the Spaniſh and Hungarian Wines.

(3.) To the third clafs belong thofe Wines which have been completely fermented, and have thrown off their grofs matter. Thefe are the moft perfect Wines, and for common ufe the moft wholfome. WINES.

Account of the principal Wines of Europe.

The principal Wines drank in Europe are as follows. (1.) The Madera iflands, and Palma one of the Canaries, afford two kinds; the firft called Madera Sec; the latter, which is the richeft and beft of the two, Canary or Palm Sec. The name *Sec* (corruptly written *Sack*,) fignifies *dry*; thefe Wines being made from half dried Grapes. There is another fort of Sec Wine, inferior to both the foregoing, prepared about Xeres in Spain, and hence called, according to our orthography, Sherris or Sherry. (2.) The Wines of Candia and Greece, particularly the latter, are of common ufe in Italy. Malmfey was formerly the produce of thofe parts only, but is now brought chiefly from Spain: It is a fweet Wine, of a golden or browniſh-yellow colour: The Italians call it *Manna alla bocca e balfamo al cervello*, "Manna to the mouth and balfam to the "brain." Zant and Cephalonia fend alfo to Venice fome good, and no fmall quantity of indifferent Wines: Almoft all the Wines indeed made ufe of in the Venetian territories come from Greece and the Morea; of which there are fome forts fo bad, and fo cheap, that large quantities are made into Vinegar for the preparation of Ceruffe. (3.) Italy, not Greece, produces the *Vino Greco:* This is a gold-coloured unctuous Wine, of a pungent fweetnefs, the growth of Mount Vefuvius, greatly fophifticated by the Neapolitans. In the neighbourhood of Vefuvius is made the *Mangiaguerra* Wine, as alfo a thick blackifh one called *Verracia*; and at the foot of the hill, the delicious *Vino vergine:* The Italians apply this laft name likewife to all the other Wines made without preffure. The kingdom of Naples affords the *Campania* or *Paufilippo* and *Mufcatel*, the *Surentine*, *Salernitan*, and other excellent Wines, as alfo the *Chiarello*, much drank at Rome. But the principal of all thefe Wines is the red, fat, fweet, and gratefully poignant one, called *Lachryma Chrifti*. (4.) The eccleſiaſtical ſtate produces the light, pleafant *Albano*; and the fweet *Montefiafcone*, a yellowifh not very ftrong Wine, which comes the neareft to good Florence, but does not keep well; together with feveral of lefs note, as the *Nomentan*, *Monteran*, *Velitrin*, *Prænetic*, *Il Romanefca*, *d'Orvieto*, &c. (5.) In Tufcany are the excellent white and red *Florence*; the celebrated, hot, ftrong red Wine *de Monte Pulciano*; the *Montalneo*, *Porte Hercole*, &c. But along the coaft of the Adriatic, at Ancona, Rimini, Pefaro, as far as Bologna, I met with exceeding bad Wines, chiefly of the boiled unfermented kind, heavy, difagreeable, and unwholfome. (6.) In Lombardy alfo there is abundance of bad Wines: The *Modenefe* and *Montferrat* are tolerable; the *Marcemino*, produced about Vicenza and Padua, pretty good. The other Wines, moft commonly drank in that province, are the *Brefcian*, *Vercnefe*, *Placentine*, *Lumelline*, and *Pucine*; and in the Genoefe, the *Vino di monte vernaccia*, *Vino amabile* or *Vino di cinque terre* and *Vino razzefe*. Between Nizza and Savona is produced an incomparable *Mufcadine*; near Aquileia is the *Rofatz*, and near Pavia the *Vino piccante*. (7.) Piemont and part of Savoy have excellent light Wines. (8.) The Sicilian, Sardinian and Corfican Wines are alfo good: The firft, as particularly the *Catanean*, *Panormitan*, *Meſſinian*, and *Syracufan*, are accounted the beft, and are chiefly bought up by the Knights of Malta. (9.) Moft of the Spaniſh Wines are compofed of fermented

WINES. or half-fermented Wine mixed with inſpiſſated Muſt and variouſly manufactured, or of an infuſion of dry Grapes in weak Muſt. No Wines freeze more difficultly than the Spaniſh, theſe abounding both with unctuous matter and with inflammable ſpirit. We have a few of theſe Wines in Germany, as the *Alicant* (which is a thick, ſtrong, very ſweet, and almoſt nauſeous Wine,) *Sherry*, *Spaniſh Malmſey*, and that ſimply called *Spaniſh Wine:* But in Spain itſelf there are many more, *Tarragan*, *Salamanca*, *Malaga*, *Cordoua*, *Galicia*, *Andaluſia*, ſundry *baſtards*, *Vino de toro*, &c. (10.) In Portugal there is plenty of red *Port*, a cheap but not a very excellent Wine, drank in large quantity in England. The beſt *Vino tinto*, a blackiſh red Wine uſed by the coopers for colouring other Wines, is ſaid by ſome to be the produce of Portugal. This kingdom deals largely alſo in *Madera*, of which the King receives yearly twelve thouſand pipes by way of tithes. (11.) In France, there is a great variety of Wines; of which the ſtrong, ſweet, full-bodied, ſpirituous ones are called *Vins de liqueur*. There is ſcarcely a province in France that does not produce Wine: Languedoc and Provence afford the ſweeteſt; and the ſame provinces, with Champagne and Burgundy, the ſtrongeſt: The Wines of the Northern parts, as Picardy and Bourdeaux, are the worſt; and thoſe about the middle of the kingdom, as Paris and Orleans, of a middling kind. The moſt celebrated of the French Wines are, *Champagne*, *Burgundy*, *Vin de Beaune* or Partridge-eye, *Cote roti*, *St. Laurence*, *Frontiniac*, *Muſcat de Lion*, *Cahors*, *Hermitage*, *Grave*, *Vin d' Haye*, &c. (12.) In Switzerland, the beſt are the *Neufchatel*, *Velteline*, *Lacote* and *Reiff* Wine: The Velteline Straw-wine, ſo called from the Grapes being laid for ſome time upon ſtraw before they are preſſed, is particularly celebrated. (13.) The dry-grape Wines of the Upper Hungary are in general excellent, and greatly ſuperior to thoſe of the Lower. They have a delicious aromatic ſmell and taſte, a notably diaphoretic and corroborating virtue, and when drank freely occaſion no headach, heavineſs of the limbs, or other inconveniencies: They do not eaſily become vinewed even in open veſſels; and retain their ſweetneſs and agreeableneſs for a length of time, though they loſe a little from year to year. (14.) Among the German Wines, the *Tyrol* are very delicate, particularly thoſe of *Tramin* and *Etſch*, but they do not keep. (15.) Good Auſtrian Wine is not to be rejected. Thoſe of Kloſter-Neuburg and Broſenberg are accounted the beſt, and ſeemed to me to excel in taſte that of Edenburg in Lower Hungary. There are alſo good Wines in ſeveral other parts of the imperial dominions. (16.) In the Palatinate, the beſt Wine is that of Worms, eſpecially the ſort called Women's Milk; and next to this, thoſe of Edinghof and Ambach. (17.) Among the more eſteemed German Wines are to be reckoned alſo *Rheniſh*, *Mayne*, *Moſelle*, *Neckar* and *Elſaſs:* A certain writer calls the Rheniſh made in Hochheim [Hock] the Prince of the Wines of Germany. (18.) The Bohemian, Sileſian, Thuringian, Miſnian, Naumberg, Brandenburg, and other German Wines, are greatly inferior to the foregoing: Some however, of thoſe of Miſnia and the Marchè, made from ripe picked Grapes, have this advantage, that they are greatly meliorated by age, ſo as to be preferred by many to the Rheniſh, Neckar and Franconia Wines, and frequently mixed with others of greater note. The tartiſh German Wines keep the

longeſt

Observations on the keeping of Wines.

longeſt of any: Some of them have been kept for two or three hundred years; and in Straſburg there is a caſk fourteen hundred years old, and many above ſeventy; the Wine being occaſionally racked off into ſmaller and ſmaller caſks, that the veſſel may be conſtantly full. Theſe very old Wines are preſerved rather for curioſity than uſe, as they not only grow too ſtrong for drinking, but at laſt quite diſagreeable. The beſt are thoſe of a middle age, from twenty to about fifty years.

Wine ſenſibly waſtes in keeping, how cloſely ſoever the caſk is ſtopt, a part tranſpiring through the pores of the wood: It is not the ſpirituous, but the watery part that is thus loſt, for the remaining Wine proves ſtronger than at firſt, and the ſtrength continues to increaſe as the quantity diminiſhes. In filling up the veſſels, for it is neceſſary they ſhould be kept full, we muſt be careful not to mix Wines of diſſimilar qualities: The Hungarian does not well bear any other Wine, particularly Rheniſh: If the ſpontaneous diminution of a caſk of Hungarian is made up with Rheniſh, though both keep extremely well by themſelves, the mixture preſently ſpoils. Cool cellars are of primary conſequence for the preſervation of Wines: It is owing wholly to want of ſufficient defence from the warmth of the weather that Wines are ſo apt to fret or run into a new fermentation on the approach of ſummer. The ſituation of Berlin does not admit of deep cellars. I have been in ſome at Vienna three ſtories deep: The cellar of the Jeſuit's college ſeemed to be not leſs than the height of a church ſteeple under the ſtreet. It is neceſſary, for the preſervation of ſome Wines, to fumigate the caſks with burning Brimſtone, to which ſome add, perhaps uſeleſsly, vinous ſpirits and aromatic ingredients: The fumes of Brimſtone ſtrongly reſiſt fermentation, but Wines that are largely impregnated with them cannot be recommended as wholſome: The colour of red Wines is deſtroyed by them. What is called *Stum*, is no other than Muſt whoſe fermentation has been prevented, or prematurely ſuppreſſed, by fumigation with Sulphur.

Colouring of Wines.

The colours of Wines are frequently artificial. A pale yellow may be natural, but a fine deep yellow proceeds from an addition of burnt Sugar or other colouring matters, or from the oaken caſks: Wines may be naturally of a pale dilute red, but a deep red is almoſt always the effect of artificial additions, as the red woods, Bilberries, *&c.* In France, no ſecret is made of theſe practices, the colouring matters, after they have been uſed, being publickly thrown out.

Curation, flavouring, *&c.*

Turbid Wines are fined by a mixture of whites of eggs, powdered Alabaſter and Fiſh-glue; ſome uſe the plant *Lycopodium:* Acid ones are cured by an addition of Salt of Tartar or abſorbent earths, in ſuch quantity as to abſorb and neutralize only the redundant acid, and not that which is eſſential to the Wine, for in this caſe the liquor would ſoon become vapid: Weak Wines are improved by an addition of ſpirit, particularly before the fermentation is completed, for after this period it is apt to ſpoil the vinoſity: Poor Wines are enriched by ſweets, and flavoured by various additions ſo as to emulate the more coſtly: Thus Elder-flowers give the flavour of Moſelle: Even the more delicious Wines have been imitated alſo without a drop of the juice of any kind of Grape; with ſolutions of Sugar, juice of Currants, Figs, and other fruits.

Some

WINES. Some of the dealers in Wines have had recourſe to artifices of a more dangerous kind, which have been pernicious to thouſands: They have ſweetened acid Wines by Litharge or other preparations of Lead; and impregnated ſweet ones with Mercury-ſublimate and with Arſenic. Lead is diſcovered in Wines by adding a decoction of Orpiment made in Lime-water: If the Wine is genuine, it does not ſenſibly change its colour on this addition, though on ſtanding, a yellowiſh-white powder falls to the bottom: If it has any ſaturnine impregnation, its colour becomes immediately darker, brown, reddiſh, or blackiſh. Arſenic may be detected by a ſolution of Lead in Aqua fortis; and Mercury-ſublimate, by volatile alcaline ſpirits, or by a ſolution of fixed alcaline Salts.

Dangerous ſophiſticatiions of Wines, diſcovered.

Characters of good Wine. The goodneſs and wholſomeneſs of Wines are judged, from their being bright, clear, and ſparkling in the glaſs; of an agreeable reviving ſmell and taſte; leaving, when held in the mouth for ſome time, a ſlight ſenſe of aſtringency; being moderately ſtrong and ſpirituous; paſſing freely by urine; exciting appetite; producing a gentle ſweat in the night; keeping the belly open next day; without being followed by any headach, heavineſs of the limbs, or other uneaſineſs. Such a Wine, moderately uſed, is a very valuable cordial. The ſweet rich Wines are either new, or very ſtrong and fiery: They heat the blood much more, and if drank to any degree of exceſs, their effects continue much longer than thoſe of the thinner Wines that contain an equal quantity of ſpirit. The red Wines in general have the greateſt aſtringency.

Chemical analyſis. The principles of which Wines conſiſt are, (1.) Water, the baſis of all fluids; (2.) inflammable ſpirit; (3.) a fine ſaline matter, which ariſes in diſtillation immediately after the ſpirit, called by Becher *Media ſubſtantia vini*; (4.) A groſſer Salt called Tartar, which in part ſeparates on ſtanding and adheres to the ſides of the caſk in ſolid maſſes; (5.) A gummy or mucilaginous ſubſtance, and (6.) a groſs unctuous or reſinous one. The following table exhibits the quantity of the ſeveral principles in a quart of each of the Wines I have examined.

Aland

WINES.

Table of the contents of different Wines.

	Highly rectified ſpirit.			Thick, oily, unctous, reſinous matter.			Gummy and tartareous matter.			Water.			
	oz.	dr.	gr.	oz.	dr.	gr.	oz.	dr.	gr.	lb.	oz.	dr.	gr.
Aland	1	6	00	3	2	00	1	5	00	2	5	3	00
Alicant	3	6	00	6	0	20	0	1	40	2	2	6	00
Burgundy	2	2	00	0	4	00	0	1	40	2	9	0	20
Carcaſſone	2	6	00	0	4	10	0	1	20	2	8	4	30
Champagne	2	5	20	0	6	40	0	1	00	2	8	3	00
French	3	0	00	0	6	40	0	1	00	2	8	0	20
Frontignac	3	0	00	3	4	00	0	5	20	2	4	6	30
Vin Grave	2	0	00	0	6	00	0	2	00	2	9	0	00
Hermitage	2	7	00	1	2	00	0	1	40	2	7	5	20
Madera	2	3	00	3	2	00	2	0	00	2	4	3	00
Malmſey	4	0	00	4	3	00	2	3	00	2	1	2	00
Vino de Monte Pulciano	2	6	00	0	3	00	0	2	40	2	8	0	20
Moſelle	2	2	00	0	4	20	0	1	30	2	9	0	10
Muſcadine	3	0	00	2	4	00	1	0	00	2	5	4	00
Neufſchatel	3	2	00	4	0	00	1	7	00	2	2	7	00
Palm Sec	2	3	00	2	4	00	4	4	00	2	2	5	00
Pontack	2	0	00	0	5	20	0	2	00	2	9	0	40
Old Rheniſh	2	0	00	1	0	00	0	2	20	2	8	5	40
Rheniſh	2	2	00	0	3	20	0	1	34	2	9	1	06
Salamanca	3	0	00	3	4	00	2	0	00	2	3	4	00
Sherry	3	0	00	6	0	00	2	2	00	2	0	6	00
Spaniſh	1	2	00	2	4	00	9	4	00	1	10	6	00
Vino Tinto	3	0	00	6	4	00	1	6	00	2	0	6	00
Tockay	2	2	00	4	3	00	5	0	00	2	0	3	00
Tyrol red Wine	1	4	00	1	2	00	0	4	00	2	8	6	00
Red Wine	1	6	00	0	4	40	0	2	00	2	9	3	20
White	2	0	00	0	7	00	0	3	00	2	7	0	00

From theſe experiments it appears that the red Wines of our own country [the Marche of Brandenburg] contain moſt water, Malmſey moſt ſpirit, Vino Tinto moſt unctuous matter, and Spaniſh the moſt gummy and ſaline matter; that this laſt holds the leaſt water and the leaſt ſpirit, Champagne the leaſt Tartar and Mucilage, and ordinary Rheniſh the leaſt unctuous matter.

Altered irrecoverably, by the ſeparation of any of their principles.

When once the principles of Wine are ſeparated from one another, no art can reproduce Wine by joining them together again: When barely the inflammable ſpirit has been diſtilled off, the addition of that ſpirit to the reſiduum does not reſtore its vinoſity: The reſiduum itſelf often ſuffers a new ſeparation upon this addition, its tartareous parts precipitating.

Congelation.

When Wines are expoſed to the action of a freezing air, a part of their water congeals, and the unfrozen part proves proportionably ſtronger and more ſpirituous: By repetitions of this proceſs, firſt pointed out by Paracelſus and ſince carried

WINES. carried to a greater length by Stahl, the beſt Wines are reduced to about one ſixth of their original volume. Wines thus concentrated or freed from their redundant phlegm, are no longer the delicate liquors they were before: They are too unpleaſant, as well as too ſtrong, to be drank by themſelves, and when mixed with other Wines, communicate to them alſo a diſagreeable taint. The phlegm which congeals retains a part of the truly vinous matter, as appears from its being convertible into Vinegar; but this phlegm, mixed with the unfrozen Wine, does not reſtore its priſtine qualities: Both the phlegm by itſelf, and the mixture, ſoon corrupt.

MALT LIQUORS.

MALT LIQUORS. SWEET vegetable liquors are the only ones diſpoſed to vinous fermentation. The ſeveral kinds of grain, as Barley, Wheat, Rye, Oats, Buckwheat, *&c.* and the ſeeds of leguminous plants, as Peas, Tares, Lentils, *&c.* when they begin to vegetate, are remarkably ſweet; and in this ſtate, called Malt, they readily communicate their fermentable ſweetneſs to boiling water.

Subjects of vinous fermentation.

Malt. Malt is prepared chiefly from Barley, by ſteeping it in water till it ſoftens and ſwells, and then laying it in heaps till it begins to ſprout: When this happens, the vegetation is ſtopt by ſpreading it abroad thin, and afterwards completely drying it by the ſun's heat where that heat is ſufficient, or in kilns warmed by culinary fire: According as the heat is leſs or greater, the Malt itſelf, and the tincture which it gives to water, are of a paler or a browner colour. Different ſorts of grain differ in their facility of vegetation: The ſame ſort alſo vegetates ſooner or later according as it is new or old. Hence the impropriety of malting different ſorts, or one ſort of different ages, together: The proceſs ſhall be finiſhed in one before it is begun in another; ſo that either a part muſt remain unmalted, or a part muſt be overmalted: In this laſt caſe, the infuſion of the compound is diſpoſed, according to the proportion of the unmalted part, to an acid rather than a vinous ſtate.

Differences of ferments. Infuſions of Malt, or watery ſolutions of its ſweet matter, have leſs propenſity to fermentation than the juices of ſweet fruits, and require always the aſſiſtance of yeaſt or ſome other actual ferment. The quality of this ferment greatly influences that of the liquor: It ſeems in ſome meaſure to aſſimilate, as it were, the whole maſs of liquor to its own nature, or to that of the liquor from which it was taken. How different are the products obtained from infuſions of the ſame Malt, by uſing Yeaſt of Beer, and the Yeaſt or Lees of generous Wine for a ferment! How ſmall a portion of putrid Yeaſt is ſufficient to ſpread putrefaction through immenſe quantities of wort! When waters uſed for brewing have received an impregnation from the carcaſes of animals, though ſo ſlight as not to be perceived in the water itſelf; as ſoon as the liquor has been brought into fermentation, the putrid ferment has exerted its activity, and diſpoſed the fermentation to its own kind——Great differences are obſerved in waters in regard to their fitneſs for brewing: It is remarkable, that the waters of rivers, and of ſtagnant ponds that are not putrid, though quite muddy, and unfit for drinking, and even diſguſtful, produce better Beer than thoſe of the fineſt and moſt limpid ſprings. Perhaps it is their ſoftneſs

Differences of waters.

that

that adapts them to this uſe, whilſt their impurities are ſeparated in the courſe of the fermentation. MALT LIQUORS.

Though infuſions of Malt are of themſelves little diſpoſed to vinous fermentation; when once that proceſs has begun, they tend ſtrongly to run beyond it: In very hot weather, the fermentation can ſcarcely be checked at the period of true vinoſity. Hence Malt-liquors are moſt ſucceſsfully prepared in the winter and ſpring: And hence the warm climates can hardly make any tolerable beer. Fermentability.

Theſe liquors are rendered much more durable, leſs apt to grow ſour, leſs viſcid, and in general more wholeſome, by the aromatic bitterneſs of the Hop. The hop contains a ſubtile odorous principle, which promotes the effect of the vinous fermentation: If infuſed, or but lightly boiled in the wort, it ſenſibly increaſes the ſpirituoſity: If boiled for a longer time, its volatile principle is diſſipated, the beer proves bitterer, but receives no additional ſtrength. Hops.

Sundry other ſubſtances have been employed for augmenting the inebriative power of malt-drinks, to the injury of their ſalubrity; as Clary, Cocculus indus, and the plant called Bohemian-roſemary (*Ciſtus ledon foliis roriſmarini ferrugineis C. B.*) which laſt produces a quick and a raving intoxication. Oftentimes alſo different medicinal ſubſtances are added, with a view to render the liquor ſerviceable in particular diſeaſes. The active powers of many vegetables are not only effectually extracted, but extended and multiplied as it were, by fermentation: So much pounded nutmeg as will lie on the point of a knife, gives a flavour to a large vat of fermenting beer; whereas, when the fermentation is finiſhed, the quantity to which it gives a like impregnation, is comparatively inconſiderable. Inebriative additions. Activity of vegetables increaſed by fermenting liquors.

I have examined ſeveral of the German malt-liquors, both pale and brown, in regard to their quantity of ſpirit, the quantity of ſolid matter left upon inſpiſſating them, and their degree of acidity, for they are all found, even in their ſoundeſt ſtate, to be more or leſs acid: The acid principle cannot perhaps be collected ſeparately, but it readily diſcovers itſelf by neutralizing fixt alcaline Salts. The ſtrongeſt of the liquors I examined yielded, upon the quart, ten drams of inflammable ſpirit; and the weakeſt of thoſe that are called Strong-beers, five drams: Of common Table-beers, ſome gave four and ſome three drams. The ſolid matter amounted in ſome to near five ounces, in others only to one ounce three drams; in the Table-beers, to three ounces and a half. The largeſt quantity of fixed alcali, ſaturated by a quart, was four drams thirty-four grains; and the ſmalleſt, one dram twelve grains. Contents of different Malt liquors.

It is obſervable, that when Malt-liquors turn ſour, the bitterneſs of the hop, though ſtrong before, is covered or over-powered by the acidity. It is not however deſtroyed: On adding an alcaline Salt or abſorbent Earth, in ſufficient quantity to obtund the acid, the liquor taſtes bitter again as at firſt.

INFLAMMABLE SPIRITS.

VINOUS SPIRITS.

INFLAMMABLE Spirits are extracted from fermented liquors by diſtillation. As firſt diſtilled, they abound with phlegm, and contain ſo much of the groſs Oil of the ſubject, that has not been attenuated or thrown off by Differences in them, as firſt diſtilled.

VINOUS SPIRITS.

the fermentation, as to receive from thence particular flavours. Thoſe drawn from Malt-liquors are in general nauſeous; thoſe from Wines, more grateful. The Brandies of France are all obtained from Wine, thoſe of Germany from Malt: In England, a ſpirit is prepared from Malt for inferior uſes, and a finer one from Melaſſes, or the ſyrupy matter which ſeparates in the making or refining of Sugar: The rums of the American iſlands are likewiſe the produce of the Sugar-cane (*q*).

Methods of determining their ſtrength.

There are different methods of eſtimating the ſtrength of theſe ſpirits—— 1. On ſhaking a little in a vial, a number of bubbles riſe upon the ſurface: The more numerous the bubbles, and the more quickly they diſappear, the more ſpirituous is the liquor. 2. If ſome of the Spirit be poured upon Oil Olive or Oil of Almonds, the Oil ariſes to the ſurface, more or leſs haſtily according as the liquor contains more or leſs phlegm: In pure ſpirit it does not ariſe at all. 3. The hydrometer is a very convenient inſtrument for determining the ſtrength of theſe liquors: It conſiſts of a glaſs ball with a ſlender ſtem divided into a number of equal parts, adjuſted, in regard to weight, ſo as to ſink to a certain point in ſpirit of a determined ſtrength; thoſe ſpirits, in which it ſinks further or not ſo far, are proportionably ſtronger or weaker than the ſtandard. 4. Some ſet the brandy on fire, and judge of its ſtrength from the quantity of phlegm or water that remains after the burning: Such as leaves half its quantity is held to be of a ſufficient ſtrength for brandy, and called proof. The phlegm thus freed from the ſpirituous part, will readily diſcover by its taſte, how much or how little the brandy participated of nauſeous matter (*r*).

Inflam-

(*q*) *Spirit from Malt, &c.*] Malted barley affords the largeſt quantity of Spirit, of any kind of grain that has been tried, except Rye, which is ſaid by ſome to yield near one third more. In the Swediſh tranſactions, there are ſome experiments of diſtilling a Spirit from potatoes. Sixteen meaſures of potatoes were boiled with Water, and worked with the liquor till the whole became a tough dough: This was diluted with boiling water to the conſiſtence of thin gruel, and fermented: The fermentation went on well, and the liquor, diſtilled on the third day, yielded one meaſure of good Brandy. The potatoes did not ſettle, or burn to the ſtill, as might have been ſuſpected. The author, Mr. Skytte, makes a compariſon, from this experiment, of the profits in cultivating Potatoes and Barley for the purpoſes of diſtillation: He computes, that the produce of ſpirit from Potatoes is to that from Barley, in equal extents of ground, as 566 to 156, even admitting the Potatoes to be planted in the worſt kinds of ground, and the Barley in ſo good a ſoil as to yield an increaſe of fifty fold.

(*r*) *Methods of eſtimating the ſtrength of ſpirits.*] Of all theſe methods, that by the hydrometer appears to be the moſt accurate. The hydrometer ſhould be graduated for this purpoſe by marking the height to which it ſinks in pure water, in pure ſpirit, and in mixtures of different proportions of the two; for dividing the ſtem into a number of equal parts betwixt the two extremes will not anſwer. It is the ſpecific gravity of the liquor that this inſtrument meaſures, and the ſpecific gravity of mixtures of water and ſpirit does not correſpond to the mean gravity of the two ingredients. In theſe mixtures, as in ſundry metallic ones formerly mentioned, there ſeems to be more than a bare juxtapoſition of the particles of the two fluids; a part of one ſeems to be received within the pores or vacuities of the other. If a certain volume of pure water weighs 1000, the ſame volume of the pureſt Abohol or moſt highly

Inflammable ſpirits, perfectly purified from their phlegm and their groſs Oil, are not found on any trial to differ or to be diſtinguiſhable from one another, whatever ſubject they were produced from. The purification is effected by repeated diſtillations in a gentle heat. Particular diſtilling veſſels have been contrived for this purpoſe, of a ſpiral form and an extraordinary height: Through theſe it was expected that the lighter ſpirit would ariſe pure, leaving all the Water in its paſſage. I have tried the celebrated ſerpentine in the royal elaboratory of Paris, but without the pretended ſucceſs: The Water, by a boiling heat, paſſed through every curvature and circumvolution of the inſtrument, along with the ſpirit, and the diſtilled ſpirit was juſt as phlegmatic as if the common ſtill had been uſed. This pompous and expenſive apparatus has therefore no advantage above the common one; the purity of the Spirit from Water, depending in either caſe, ſolely upon the gentleneſs of the fire. The ſpirit, in its ſeparation from the phlegm, leaves alſo greateſt part of the nauſeous oily matter behind, but oftentimes a part comes over with it: If the diſtilled Spirit be mixed with a quantity of pure Water, its Oil is extricated by the Water, and on careful rediſtillation it ariſes pure from both. Sundry additional matters have been employed for expediting the proceſs by abſorbing and detaining the Oil and Phlegm; as fixed alcaline Salts, Sea-ſalt, Quick-lime, *&c.* Fixt alcalies anſwer the beſt: By theſe, ſpirits may be rectified even without diſtillation. If a quantity of pure and dry fixed alcaline Salt be put into a phlegmatic Spirit, it imbibes the phlegm and the oily matter, and forms with them a thick ponderous liquid, which falls to the bottom, and from which the Spirit may be eaſily poured off: How ſtrongly ſoever the two liquors are ſhaken together, they preſently ſeparate upon ſtanding at reſt. Spirits thus rectified are not entirely pure: They contain ſome ſmall portion of the alcali, ſufficient to communicate a degree of pungency, that may render them for ſome purpoſes unfit *(s)*.

VINOUS SPIRITS.

Are ſimilar when rectified.

Rectification.

Spirit

highly rectified ſpirit will weigh 820; the ſame volume of a mixture of equal parts of the two will weigh, not the medium 910, but nearly 925. If one meaſure of water and one meaſure of ſpirit be mixed together, the quantity of the mixture will be very ſenſibly leſs than two meaſures.

From the riſing or ſinking of Oil in the ſpirit we can form only a groſs judgment of what the hydrometer (if the liquor is brought to an equal temperature in regard to heat) meaſures with preciſion. The quantity of bubbles on the ſurface depends rather on the oilineſs of the ſpirit than on its ſtrength; for weak ſpirits may be made to exhibit the ſame phænomena in this reſpect as the ſtronger, by impregnating them with Oil: From inattention to this circumſtance, ſome of the workmen have been miſled into an opinion, that the ſpirit proves ſtronger when the fire in the diſtillation is kept to ſuch a height as to make the ſpirit run in a full ſtream, than when a gentler fire is uſed; a ſtrong heat forcing over more of the Oil, and conſequently making the ſpirit aſſume a greater quantity of bubbles on being ſhaken. In regard to the quantity of water left on burning, it depends more upon the manner in which the ſpirit is burnt than upon its ſtrength, as will appear hereafter.

(*s*) *Part of the alcali retained by the ſpirit.*] A part of the alcali ariſes alſo along with the ſpirit in diſtillation, and communicates to it what the workmen call an urinous flavour. This may be prevented by adding an acid, particularly the vitriolic, previous to the diſtillation; the acid not only neutralizing the alcaline Salt, but preventing it from ariſing. It would be imprudent to add the vitriolic

VINOUS SPIRITS. Spirit of Wine is the general name of rectified Spirits, whatever ſubject they were prepared from; but is never applied to proof ſpirits though drawn from Wine itſelf. Spirits brought to the higheſt degree of purity, both from phlegm and Oil, are called Alcohol. By diluting rectified ſpirit with a ſuitable quantity of pure water, we obtain a pure and flavourleſs proof ſpirit. When phlegmatic or proof-ſpirits are required for chemical or other curious uſes, they ought always to be prepared in this manner (*t*).

Criteria of highly rectified ſpirit. Spirit of Wine, ſet on fire in a ſpoon or ladle, burns wholly away, without leaving any ſenſible humidity. A little Gunpowder, placed at the bottom, takes fire as ſoon as the ſpirit is burnt off; and this is the common mark of the ſpirit being ſufficiently rectified; for if it contains any conſiderable quantity of phlegm, this phlegm remaining after the ſpirit is conſumed, will prevent the Gunpowder from taking fire. The makers of varniſh, who require very ſtrong ſpirits, prefer Cotton as a nicer teſt, this being leſs eaſily inflammable than Gunpowder; and a ſmaller proportion of aqueous humidity preventing its burning. A ſpirit that fires Cotton is looked upon as quite pure from phlegm.

Analyſis of rectified ſpirit. Though rectified ſpirits give no ſigns of water upon theſe trials, a further examination diſcovers that they abound with that element. Burn the ſtrongeſt ſpirits in a deep mortar, or in a veſſel kept floating in cold water, and a quantity of moiſture will remain unconſumed. I made ſeveral experiments on this ſubject at Paris, in concert with the younger Geoffroy, who afterwards gave an account of them to the French Academy: From the beſt ſpirits, ſuch as fired both Gunpowder and Cotton, we gained, by burning them in the open air, one third their weight of water; and under an open glaſs receiver, one half. I have ſince collected much larger quantities, by burning the ſpirit in an apparatus which ſuffered leſs of the phlegm to eſcape into the air.

Pure ſpirit is in effect, no other than an intimate combination of water with an Oil; not ſuch an Oil as we ſeparate in the rectification, but one that has been highly ſubtilized by the proceſs of fermentation: An actual Oil is obtainable from the pureſt ſpirit, by diſtilling it with the vitriolic acid. Theſe ſpirits contain alſo a portion of acid, which probably ſerves as the band of union between the Oil and the water: On repeatedly abſtracting freſh quantities of them from one and the ſame parcel of fixed alcaline Salt, the Salt becomes at length neutral, and nearly ſimilar to alcalies neutralized by Vinegar.

Vinous ſpirits as menſtrua. Vinous ſpirits are of very extenſive uſe in chemiſtry and the chemical arts; as for ſeparating the medicinal parts of vegetable and animal ſubſtances, from the inactive matter; extracting their flavours and colours for various uſes; diſſolving Reſin and Oils for varniſhing and lacquering; preſerving animal and vegetable bodies from corruption.

Spirit

acid in its pure ſtate, as we could not aſcertain the proper quantity; but Vitriol itſelf, or Alum, may be uſed with ſafety, as theſe will part with no more of their acid, in the degree of heat by which vinous ſpirits are diſtilled, than what the alcali abſorbs.

(*t*) *Proof ſpirits from rectified ſpirit and water.*] Proof ſpirits are ſaid to be compoſed of equal parts of rectified ſpirit and water. If the two liquors are taken by meaſure, this proportion will pretty nearly make a ſpirit of the ſtrength commonly underſtood by proof. The exact proportions, by weight, are, one hundred parts of pure ſpirit, and eighty-ſix of water.

Spirit of Wine diſſolves all vegetable Reſins and diſtilled Oils, the ſubtile Oils of aromatic herbs, flowers, ſeeds and fruits, as Lavender, Balm, Mint, Marjoram, Citron-peel, very readily and plentifully; thoſe of woods and roots, as Rhodium and Saſſafras, more difficultly and ſparingly; thoſe diſtilled from reſinous ſubſtances, as Turpentine, and from mineral bitumens as Amber, ſtill more difficultly. It diſſolves empyreumatic Oils as well as the eſſential; and by diſtillation and repeated cohobation, renders them extremely ſubtile. Pure expreſſed Oils, and animal Fats, it does not unite with at all; but theſe alſo are rendered ſoluble in it by combining them with fixed alcaline Salts into Sope. It mingles with water, and produces a conſiderable heat on being mixed with it. It coagulates Blood, Milk, and whites of Eggs, and moſt of the animal juices, except Urine and Bile. It mingles with all acids, concentrated and diluted, of the mineral or vegetable kingdom: On its mixture with the concentrated mineral acid ſpirits, a ſtrong ebullition and heat enſue, the acidity is obtunded or deſtroyed, and the compound proves a ſubtile, volatile, fragrant fluid (*u*). It does not act in the leaſt upon pure Sulphur; but from Sulphur combined with fixed alcaline

VINOUS SPIRITS.

(*u*) *Combination of vinous ſpirits with mineral acids.*] Spirit of Wine produces the greateſt heat and ebullition on mixture with the nitrous acid; and the leaſt with the marine. The conflict is conſiderably more violent, and the noxious fumes more copious, when the vinous ſpirit is dropt into the acid, than when the acid is dropt into the vinous; a circumſtance to be carefully attended to by the operator in making theſe mixtures, eſpecially when the quantities are large. When the two ſpirits are intimately combined together into a fragrant liquor, in which no acidity can be perceived, the acid is ſaid to be *dulcified.* The union is promoted by digeſtion; but the dulcification is never perfect without a ſubſequent diſtillation. As ſome ſingular phænomena occur in theſe operations, it will be proper to conſider them more particularly.

With the vitriolic acid.] Concentrated Oil of Vitriol being dropt by degrees into an equal quantity, or five or ſix times its quantity, of highly rectified Spirit of Wine, the liquor becomes firſt yellow and then reddiſh, and exhales an agreeable, diffuſive, penetrating ſmell, which if freely taken in with the breath, affects the lungs: The taſte of the liquor is conſiderably acid.

On digeſting the mixture for ſome days, and then committing it to diſtillation in a retort with a very gentle warmth, there ariſes a ſubtile ſpirit, more fragrant and penetrating in ſmell than the undiſtilled liquor, very volatile, inflammable, in taſte not at all acid, but of the aromatic kind. This is the dulcified Spirit of Vitriol. It comes over in thin inviſible vapours, which condenſe upon the ſides of the recipient in ſtreight ſtriæ.

This ſpirit is ſucceeded by one of a different kind; which being caught in a ſeparate receiver, is found to be ſenſibly acid, and of a pungent ſuffocating ſmell like the fumes of burning Brimſtone. Along with it comes over a ſmall quantity of Oil; which ſometimes proves colourleſs and ſwims on the ſulphureous liquor, and ſometimes appears yellowiſh or greeniſh and ſinks to the bottom, according as the vinous ſpirit in the mixture was in large or in ſmall proportion.

In all the diſtillations I have made, this ſulphureous ſpirit aroſe in white fumes, which either formed irregular ſtriæ, or were collected into large round drops like Oil: The appearance of theſe fumes conſtantly gave notice of the time for changing the receiver. Mr. Hellot ſays, that in perfectly cloſe veſſels, theſe vapours are not to be diſtinguiſhed, any more than thoſe of the dulcified ſpirit; that when the retort was made to fit exactly into the receiver, the neck being ground with Emery for that purpoſe, they were not to be ſeen till the juncture was looſened a little; and that on looſening, and ſtopping it tight, they appeared and diſappeared for ſeveral times ſucceſſively.

On

VINOUS SPIRITS.

On continuing the diſtillation, a black froth begins haſtily to ariſe, and prevents our carrying the proceſs further. The matter which remains in the retort, is of a dark blackiſh colour, and ſtill highly acid. Treated with freſh Spirit of Wine, in the ſame manner as before, it yields the ſame productions, till at length, all the acid that remains unvolatilized being ſatiated with the inflammable oily matter of the ſpirit, the compound proves a bituminous ſulphureous maſs; which expoſed to the fire in open veſſels readily burns, leaving a conſiderable quantity of fixed aſhes; in cloſe ones, explodes with violence; and with fixed alcaline Salts forms a compound ſimilar in ſome reſpects to one compoſed of alcalies and Sulphur.

The author above-mentioned has diſcovered a method of facilitating this proceſs, in regard to the preparation of the dulcified ſpirit. By the addition of powdered Potter's-earth, in the proportion of ſix ounces to eight ounces of the acid and ſixteen of the vinous ſpirit, the ſulphureous liquor and the Oil that accompanies it are prevented, he ſays, from ariſing; and the diſtillation may be ſafely performed even with a boiling heat, and continued till the matter remains dry. See the Memoirs of the French Academy for the year 1739---It is probable, that the only uſe of this addition is, to abſorb the ſuperfluous acid; for the author obſerves that greateſt part of the Oil of Vitriol is recoverable from the Clay, by diſtilling it with a ſtronger fire. Perhaps a ſuitable diminution in the quantity of acid employed might anſwer the ſame end. Thus much is certain, that when ſix parts of the vinous ſpirit are taken to one of the acid, the quantity both of ſulphureous liquor and Oil is conſiderably leſs than when the two ſpirits are taken in equal proportions.

The Oil is of a ſtrong, penetrating, agreeable ſmell, reſembling that of the dulcified ſpirit: It very readily and totally diſſolves in rectified Spirit of Wine, and impregnates a large quantity of the menſtruum with its own odour. To the taſte, it is ſenſibly acid, eſpecially when a large proportion of acid has been employed in the proceſs: On keeping for ſome time, it becomes more remarkably ſo, acquiring at the ſame time a reddiſh hue. In this ſtate, it diſcovers a ſulphureous ſmell, effervesces with and neutralizes alcaline Salts, and being thus freed from its acid, ariſes in diſtillation more ſubtile than before, and vaſtly diminiſhed in quantity.

The dulcified ſpirit alſo has frequently ſome ſlight acidity, ſufficient to alter the fine green tincture, which in its perfect ſtate it extracts from the leaves of plants. It is purified or rectified from this redundant acid, by mixing it with a weak ſolution of fixed alcaline Salt, and diſtilling it over a ſecond time: For every pint of the ſpirit may be taken a ſolution of a dram of Alcali in a pint of water.

If the ſpirit, thus rectified, be mingled again with an equal quantity of a like alcaline ſolution, the mixture ſhaken together, appears milky: On ſtanding for a little time, there ariſes to the ſurface an extremely ſubtile fluid, called by the chemiſts Æther, or Æthereal Spirit of Wine. A conſiderable quantity of dulcified ſpirit may ſtill be ſeparated from the remaining liquor by diſtillation; and this ſpirit, mixed with freſh alcaline ſolution, affords more Æther.

The Æther is the lighteſt, moſt volatile, and moſt inflammable of all known liquids. It ſwims on the moſt highly rectified Spirit of Wine, being lighter than that ſpirit in the proportion nearly of 0,730 to 0,830. Dropt on the warm hand, it almoſt inſtantly exhales, diffuſing a penetrating fragrance, and leaving no moiſture behind. On the approach of a candle, it takes fire, and goes off in a flaſh like lightening. It does not mingle with water, with acid, or with alcaline liquors; but diſſolves ſome unctuous and reſinous bodies. Among metallic ſubſtances, it diſcovers a remarkable attraction to Gold, but ſeems to have no effect on any of the others: Mixed with a ſolution of Gold made in acids, it imbibes the Gold from the acid, carries it to the ſurface, and keeps it there diſſolved into a yellow liquor; hence its uſe for diſcovering Gold in liquids. See page 39.

The only perſon we know of, who has given any plauſible theory of the production of this ſubtile fluid, is Mr. Macquer---Spirit of Wine conſiſts chiefly of an Oil, exquiſitely attenuated by fermentation, and intimately combined with water. According to Mr. Macquer, the Æther is no other than this ſubtilized Oil, extricated by the vitriolic acid; which acid, having a ſtrong affinity

or

or attraction to water, abſorbs the watery element of the ſpirit, and thus ſets the oily one at liberty.

In the *Svenſka vetenſkaps academiens handlingar*, *år.* 1740, there is a remarkable experiment on the dulcified vitriolic ſpirit (or perhaps the Æther, for the author expreſſes himſelf a little ambiguouſly) by J. G. Wallerius. Some Salt of Tartar being mixed with the ſpirit, the full bottle ſtopt with a cork, tied over with bladder, and laid on its ſide; on ſtanding for four months, greateſt part of the ſpirit was found to have eſcaped, and the Salt was ſhot into hexangular priſmatic cryſtals like Nitre. It taſted ſtrongly of the ſpirit, but had no other particular taſte: Laid on a burning coal, it crackled and exploded with a bright flaſh, and flew with violence into the air. He afterwards found, that by adding to the ſpirit a drop or two of any acid, the Salt cryſtallizes the ſooner; that in this caſe it proves of a ſouriſh taſte, but in other reſpects is the ſame as that made without the acid. This Saltpeter, ſays the author, promiſes, from the violence of its exploſion, to make the ſtrongeſt Gunpowder in the world, but a very dear one: Though the experiment ſhould not be applicable to any uſe in this way, it will probably contribute to illuſtrate the generation of Nitre, as it palpably ſhews Nitre (that is the acid or characteriſtic part of Nitre) produced from the vitriolic acid and phlogiſton.

With the nitrous acid.] Strong Spirit of Nitre being dropt by little and little into three or four times its quantity of rectified Spirit of Wine; and the mixture, after digeſtion for ſome days, diſtilled by the heat of a water-bath, there ariſes a fragrant ſpirit, in ſome degree reſembling the dulcified Spirit of Vitriol; but which, when rectified in the ſame manner, does not, ſo far as I have obſerved, afford any Oil or Æther. The ſpirit is to the taſte gratefully pungent, not at all acid like the one ingredient, nor hot like the other: Mixed with clean Malt or Melaſſes ſpirits, it communicates a flavour like that of French Brandy. It is conſiderably leſs inflammable than Spirit of Wine, and leaves on burning an acidulous phlegm.

It is obſervable, that the vitriolic acid, in the foregoing proceſs, diſcovers itſelf in moſt of the products by its uſual characters, plainly in the ſulphureous diſtilled liquor and in the Oil that diſtils along with it, and ſtill more plentifully in the reſiduum; whilſt the whole of the nitrous acid, in the preſent proceſs, ſeems to be deſtroyed or to change its nature. To deflagrate with inflammable ſubſtances in burning, is the ſtrongeſt character of the nitrous acid; but neither the dulcified ſpirit, nor the acidulous liquor remaining after it has been burnt, nor the matter left in the retort after the diſtillation, have been obſerved to produce any deflagration.

Mr. Pott, in a diſſertation on this ſubject, has given ſome curious experiments on the oleaginous reſiduum of the diſtillation---Diſtilled by a ſtronger fire, it gave over a yellow acid ſlightly empyreumatic ſpirit; which being ſaturated with fixed alcali, the liquor evaporated, and the dry neutral Salt laid on burning coals, no deflagration enſued. After this ſpirit, aroſe a red empyreumatic Oil; and in the bottom of the veſſel remained a ſhining black maſs like Soot, which burnt in a crucible left a white fixed earth, convertible by a vehement fire into Glaſs---Another parcel of the above reſiduum was evaporated to the conſiſtence of Pitch: In this ſtate, it gave a yellow tincture to Spirit of Wine, flamed vividly and quietly on burning coals, and at laſt ſwelled up like Bitumens---Another portion was ſaturated with alcaline Ley (with which it immediately effervesced) and then evaporated as the former: It gave as before a yellow tincture to rectified Spirit of Wine, and a much deeper yellow to the dulcified Spirit of Nitre; and in the fire diſcovered no footſtep of detonation---Mr. Macquer, who mentions ſome of theſe experiments without giving them their full force, ſuſpects that the acid obſerved in them was not the nitrous changed in its quality, but the acid of the Spirit of Wine extricated by the nitrous. But what is become then of the nitrous acid, of which ſo large a proportion was made uſe of?

Though the nitrous acid does not ſeparate any æthereal Oil from Spirit of Wine, by diſtillation in a gentle heat, as the vitriolic does; it ſeparates one by ſimple mixture, and digeſtion without heat, which the vitriolic does not. Equal parts by meaſure of Spirit of Nitre and Spirit of Wine being mixed

VINOUS SPIRITS.

caline Salts, it receives a deep yellow tincture, and a notable taſte and ſmell. It has been ſaid to diſſolve no ſolid Salts; but on trial it is found to diſſolve perfectly the Sal diureticus, nitrous Sal ammoniac, the Salt called fixed Sal ammoniac, the cryſtals of Silver made with the nitrous acid, and combinations of Iron, and ſome other metallic bodies with the marine; and more difficultly Sugar, Saccharum ſaturni, and Salt of Amber: It takes up a little alſo, about one ſixth, of green Vitriol, and of Borax. Added to watery ſolutions of Salts, it in ſome caſes occaſions an inſtantaneous precipitation of the Salt, by rendering the water incapable of keeping it diſſolved: With ſome ſolutions it produces a coagulum: From ſome it precipitates the earthy or metallic baſis of the Salt, the acid being abſorbed by the ſpirit. It revives Gold from its ſolutions in form of fine Gold-leaf, and precipitates Mercury in its running form: It precipitates alſo Tin and Lead. It does not act, or at leaſt not conſiderably, upon pure alcaline Salts, either fixed or volatile, nor mingle with ſolutions of them made in water: It abſorbs the water from ſolutions of volatile alcalies, and thus precipitates the Salt; but on ſolutions of fixed alcalies it has no effect, the ſpirit ſwimming diſtinct upon the ſurface of the alcaline liquor, and quickly ſeparating from it, though they be ſtrongly ſhaken together, as Oil does from water.

T A R T A R.

TARTAR.

Its production.

THE groſs Salt, or Tartar, contained in Wines, does not diſſolve at all in ſpirit, and very ſparingly in watery liquors: By age, Wines become more and more ſpirituous, and the Tartar proportionably ſeparates and incruſtates on the ſides and bottom of the caſk. It proves of a whitiſh, yellowiſh or reddiſh colour according to that of the Wine; and more or leſs foul according as the Wine abounded more or leſs with groſs unctuous matter. The white is purer than the red; and that which ſeparates after the Wine has been long kept, than ſuch as is thrown off immediately after the fermentation.

This

mixed together, the bottle cloſely ſtopt, and ſet in a cool place; the æthereal Oil, in ſeven or eight days, ariſes to the ſurface, amounting to upwards of one fourth the quantity of the mixture. This Oil contains a part of the nitrous acid unchanged: From which it is purified by diſtillation from alcaline liquors, and is then called rectified nitrous æther. This experiment was firſt diſcovered by Mr. Navier, and communicated in the Memoirs of the French Academy for the year 1742. It does not require the two ſpirits to be very ſtrong, and is performed with the greateſt ſafety to the operator when they are but moderately ſo: When both of them are highly concentrated, there ſometimes happens, during the digeſtion, a violent exploſion.

With the marine acid] The marine acid unites with vinous ſpirits very difficultly and imperfectly: When combined with them by long digeſtion and diſtillation, it manifeſts its own ſpecific characters, and ſeems to be only diluted by the inflammable liquor. The ſpirit, diſtilled in the heat of a water-bath from one part of ſmoking Spirit of Salt and three or four of highly rectified Spirit of Wine, after twenty days digeſtion, effervesces with fixed alcalies, forms with them a regenerated Sea-ſalt, and precipitates Silver from its ſolution in Aqua fortis into Luna cornea. The matter left after the diſtillation yields, on being urged with a greater heat, a weak marine ſpirit, ſlightly empyreumatic, a pitchy or coaly matter remaining, which by calcination turns to white aſhes.

This Salt is the direct produce of fermentation, and is never to be obtained from liquors which have not undergone that process. The rich sweet Wines afford least; not, as Boerhaave supposes, from the oily matter preventing its separation, but from their really containing least, as having been least perfectly fermented. The Rhenish, Franconia and Moselle Wines yield the most of any. TARTAR.

Tartar is always the same Salt, whatever Wine it be produced from; the only difference that arises from the Wine being in the quantity of foul matter deposited along with it. It is purified by boiling it in water till the saline part is dissolved, and clarifying the strained solution with whites of Eggs: The liquor being then removed into a cool place, the Salt soon begins to concrete into very small white crystals. Purification.

Tartar is refined in large quantity at Venice, Montpelier, Tripoli, and in some parts of Germany: The crystals we are supplied with from those works are somewhat whiter, and much larger, than any I have been able to prepare; and at the same time of a cheapness scarce consistent with the troublesome process of dissolving and clarifying the Tartar by itself. Some of the chemists of the French Academy have taken great pains to discover the method of management in the Tartar refinery at Montpelier; and report, that the secret consists in employing a chalky earth, which promotes the solution of the Tartar. I have never been able to succeed with chalky or with other earths, nor with any of the additions I have made trial of. Chalk and absorbent earths in general do indeed promote the solution of the Tartar, but they unite with it into a new compound of a quite different nature; whereas the common Crystals were found on all trials the same with Tartar purified by itself.

Tartar is a manifestly acid Salt: It does not, however, change the colour of Syrup of Violets to a red, the oily matter, with which it abounds, covering its acidity. Dissolved in water, it effervesces with fixed alcaline Salts, and forms with them a neutral one, much easier of solution than the Tartar alone. It likewise effervesces with and dissolves absorbent earths, and with these also forms a neutral soluble compound, from which the tartareous acid may be expelled by the more powerful ones of the mineral kingdom. It dissolves the metallic substances that other vegetable acids do, as Iron, Copper, Lead, *&c.* (*x*). Its general properties.

Tartar,

(*x*) *Tartar.*] The acid of Tartar has been supposed by some to be similar to that of Vinegar, but is found upon experiment to be notably different. It does not, like the acetous acid, render fixed alcalies soluble in Spirit of Wine, nor form a saccharine concrete with Lead. When combined with alcaline Salts, or with absorbent earths, into a neutral Salt; Vinegar, as well as the mineral acids, added to a solution of this Salt, precipitates the Tartar in its original form, and unites with the alcali or earth in its stead.

It is observable, that all the substances, which unite with Tartar, form with it compounds easier of solution than the Tartar by itself; those of the metallic kind not excepted. Thus if Tartar and Iron-filings be boiled together in water, the liquor soon acquires a dark colour and a ferrugineous taste: On cooling, such part of the Tartar as is but slightly impregnated with the Iron, falls to the bottom in a crystalline form, the part which is fully saturated remaining dissolved in the cold: If the fluid be now evaporated, it leaves a saline mass, so easy of solution, that it runs into a liquor on being exposed to the air. The addition of alcaline Salts to this solution does not seem to precipitate the Iron from the tartareous acid; but on adding any other acid, the Tartar is

TARTAR. Tartar, expoſed to the fire in cloſe veſſels, gives over a fetid acidulous ſpirit, and an empyreumatic Oil: The remaining coal, elixated with water, yields a large proportion of fixed alcaline Salt, whilſt no ſuch Salt is producible from other vegetable matters without burning them to white or whitiſh aſhes in the open air. From a pound of Tartar were extracted about four ounces of ſpirit and phlegm, and one of Oil: The reſiduum weighed ten ounces and a half, and yielded four ounces of alcaline Salt. This is the alcali which has been chiefly made uſe of in chemical experiments, by the name of Salt of Tartar: It is not different in quality from the alcalies obtained from other vegetables, though it ſeems to have been looked upon by ſome as participating of the nature of the Tartar itſelf; whence compound Salts in which it is an ingredient are called by the name of Tartar, as vitriolated Tartar, tartarized Tartar, *&c.*

Reſolution by fire.

It is remarkable, that when four parts of powdered Tartar and three of powdered Quick-lime are mixed together, and thoroughly calcined in a crucible, the product has neither ſmell nor taſte, and being thrown into water, lies, unacted on, like a ſtone: On digeſting the maſs in water for a little time, it grows hot, and yields an exceeding ſtrong cauſtic alcali.

Its uſes. Tartar is uſed in medicine as a mild cooling purgative. Its principal conſumption is in the chemical arts, particularly dying, glaſs-making, metallurgy, in making Vinegar, Nitre, *&c.*

V I N E G A R.

VINEGAR. VINEGAR is the produce of the ſecond ſtage of fermentation. If Wines or vinous liquors be expoſed to a gentle continued warmth, the acetous fermentation ſpontaneouſly ſucceeds: A groſs tartareous and unctuous matter falls

Its production.

precipitated, the Iron which made it ſoluble, being abſorbed from it by the acid ſuperadded. Nearly the ſame phænomena are obſerved on treating Tartar with Copper, Lead, Zinc, and Regulus of Antimony, except that the combinations with theſe metals are leſs diſpoſed to deliquiate.

Tartar ſaturates about one third its weight of fixed alcaline Salt, but more than equal its weight of abſorbent earth. If the Tartar be diſſolved in boiling water, and the proper quantity of the alcali or earth be gradually thrown into the boiling liquor; the whole of the Tartar will be ſaturated at once, ſo as to yield on cryſtallization a Salt perfectly neutralized and eaſily ſoluble. Metallic bodies on the other hand, though long boiled with a ſolution of Tartar, ſaturate only a part of it, and commonly but a ſmall one: The Cryſtals which ſeparate firſt from the liquor are little other than Cryſtals of Tartar; thoſe which ſucceed are more and more impregnated with the metal; the part which is fully ſaturated remaining diſſolved to the laſt. This property of Tartar ought to be well attended to, in the proceſſes of impregnating it with metallic bodies, as particularly with the reguline part of Antimony, for medicinal uſe. See page 137.

Borax, a Salt very difficult of ſolution by itſelf, has a remarkable effect on Tartar. Two ounces of Borax and four of Cryſtals of Tartar diſſolve, (without the efferveſcence which Tartar always excites with alcaline Salts and earths) in twelve ounces of water; which is no more than about one ſixth part of the quantity that would be neceſſary to diſſolve them ſeparately. On evaporating the liquor, the Salts concrete into an acidulous, viſcous, tenacious maſs, like Glue, which refuſes to cryſtallize, and which if exſiccated by heat, deliquiates again in the air.

In all theſe combinations of Tartar, its acid continues united with its groſs Oil and earth: Nor do we know of any method of extricating or ſeparating it from them, or of transferring it into any other body.

falls to the bottom; the inflammable ſpirit is reſolved or deſtroyed, and perhaps a part of it eſcapes; the liquor gradually loſes its conſiſtence, its ſweetneſs and its vinous flavour, and becomes a thin acid Vinegar. The acetous fermentation naturally follows the vinous, but is not neceſſarily preceded by it; Vinegar being producible without any intermediate ſtate of vinoſity. VINEGAR.

When Vinegar has run a little beyond the acetous ſtate, and begun to enter on the putrefactive, it is ſtill in the power of art to recover it. The putrefaction may be ſtopt by quenching a red-hot Iron in the liquor; and the acid, which has been loſt or deſtroyed, may in ſome meaſure be reſtored, by the addition of a little Spirit of Wine, Rye-bread, Muſtard-ſeed, *&c.* The putrefaction of Vinegar is prevented in the ſame manner as the fretting or acetification of Wine; by racking it off from the feculencies, and keeping it in a cloſe ſtopt veſſel in a cool place. Such as has once ſuffered a conſiderable heat, cannot long be preſerved from corruption. Recovery from ſlight corruption.

Vinegar is compoſed of phlegm or water, the proper acetous acid, a groſſer acid approaching to that of Tartar, and an unctuous or oily matter. In diſtillation with a gentle fire, the phlegm and the acetous acid ariſe, with ſome of the finer parts of the Oil, the tartareous acid, and the groſſer Oil, remaining at the bottom. The Vinegars made from Malt-liquors contain more unctuous matter than thoſe from Wine, and give out their acid more difficultly. Vinegar ſeems to contain alſo a ſmall portion of the vinous ſpirit, that has not been changed or ſubdued by the fermentation. Its principles.

The diſtillation of Vinegar in retorts, recommended by ſome, is very troubleſome and incommodious. The beſt apparatus is a glaſs body or a pewter ſtill, fitted with a glaſs or ſtone-ware head. The compilers of the Brandenburg Diſpenſatory have judiciouſly ordered the diſtillation to be performed in a water-bath, but ſubjoin a very needleſs caution of guarding againſt an empyreuma: The very advantage of the water-bath is, that we may ſafely draw over all that will ariſe, without danger, and even without a poſſibility, of giving any empyreumatic taſte or ſmell to the ſpirit. The phlegmatic part, which diſtils at firſt, may be thrown away; and the weaker acid, which comes over next, kept apart from the ſtronger acid that follows. Diſtillation of Vinegar.

The matter remaining after the diſtillation, urged with a ſtronger fire in a retort, yields an empyreumatic Oil, and an extremely acid tartareous ſpirit, tainted with the burnt flavour of the Oil, from which it may be in good meaſure freed by repeated diſtillation. From the coal left in the bottom of the retort, may be obtained, by burning it in the open air, a fixed alcaline Salt more ſubtile and penetrating than the common alcalies. If Vinegar be drawn over from Quick-lime, and the remaining maſs diſtilled in a retort, there ariſes a ſtrong volatile alcaline ſpirit, which acts notably on ſome metallic bodies. Thus is a part at leaſt of this acid liquor convertible by ſimple proceſſes into alcalies both fixed and volatile. Further examination by fire.

The ancients mixed Vinegar with different kinds of ſubſtances for medicinal uſe, and diſtinguiſhed the mixtures by different names expreſſive of the ingredients: Their *Oxycraton* or *Poſca* was compoſed of Vinegar and Water; *Oxeleum*, of Vinegar and Oil; *Oxalme*, of Vinegar and Salt-water; *Thymoxalme*, of Vinegar and Salt-water impregnated with Thyme; *Oxylepus*, of Vinegar and Preparations.

VINEGAR. the *Cortex fabarum*; *Oxyrrhodinum*, of Vinegar and Oil of Roſes or Roſe-water; *Oxyſaccharum*, of Vinegar and Sugar; and *Oxyglyci*, or *Oxymel*, of Vinegar and Honey. *Oxyſacchara* and *Oxymels* are ſtill retained in practice: They are prepared by diſſolving Sugar or Honey in a proper quantity of Vinegar, with or without the addition of other ingredients, and boiling down the mixture to the conſiſtence of a ſyrup: They are, in effect, no other than ſyrups, made with Vinegar inſtead of water.

Medicated Vinegars. Medicated Vinegars are infuſions of different vegetable ſubſtances made in this acid liquor. If the Vinegar is digeſted with the herbs, flowers, &c. in a glaſs body or other convenient veſſel, with a gentle heat, it becomes impregnated with their virtues much more ſpeedily and effectually than by the expoſure to the ſun generally directed. Vinegar may likewiſe be medicated or flavoured by adding the ſubject to the Wine or to the Muſt at firſt: There are many vegetables whoſe ſmell and taſte reſiſt both the vinous and acetous fermentation, and remain ſtrong in the Vinegar.

Vinegar as a menſtruum. Vinegar diſſolves all the earths that the mineral acids diſſolve, and ſeveral of the metallic bodies. Lead is corroded by its vapour into Ceruſſe or white Lead: Ceruſſe, or the calces of Lead made by fire, diſſolve in Vinegar, and on inſpiſſation ſhoot into Cryſtals called *Saccharum ſaturni*. From Iron and Steel are prepared, by this acid, Chalybeate tinctures and extracts. Copper is corroded by it (or by the aceſcent preſſings of Grapes) into Verdegris. See the ſeveral metals in the firſt part of this work (*y*). Saturated with volatile alcalies, it forms a neutral ſaline liquor, which in diſtillation totally ariſes in a fluid

(*y*) *Vinegar as a menſtruum for metallic bodies.*] This acid differs remarkably in its action on different metallic bodies, according as they are in their perfect metallic ſtate, or changed by fire or by other menſtrua, into the ſtate of a calx or crocus.

It diſſolves Zinc very eaſily, and Biſmuth more difficultly, in both ſtates. It diſſolves Iron-filings very readily, but ſcarce has any action on the calces of Iron. Filings of Lead on the other hand are very difficultly acted on, but the calces diſſolve more eaſily: Vinegar boiled even with the glaſs of Lead, or in the common glazed earthen-veſſels, in whoſe glazing this metal is a principal ingredient, extracts a notable quantity, ſo as to become ſtrongly impregnated with the pernicious qualities of the Lead, and to yield on evaporation a true *Saccharum ſaturni*. The antimonial Regulus alſo, both in the form of Glaſs and in its metallic ſtate, gives a ſtrong impregnation to Vinegar, whilſt its calces, made by deflagration with Nitre, ſeem to be unaffected by it.

The habitude of Tin to the acetous acid has been diſputed. Our author finds (page 88.) that this metal does not diſſolve in it; and on the other hand Mr. Marggraf affirms (in the Berlin Memoirs for the year 1747) that it diſſolves with eaſe. On trial I obſerved, that plates of pure Tin, put into common Vinegar, begun in a few hours to be corroded, without the application of heat: By degrees a portion of the metal was taken up by the acid, but did not ſeem to be perfectly diſſolved, the liquor appearing quite opake and turbid, and depoſiting great part of the corroded Tin to the bottom in form of a whitiſh powder. A part of the Tin, if it is not truly diſſolved, is exquiſitely divided in the liquor; for after ſtanding for many days, and after paſſing through a filter, ſo much remained ſuſpended, as to give a whitiſhneſs and opacity to the fluid. Acid juices of fruits, ſubſtituted to Vinegar, exhibited the ſame phænomena. Theſe experiments are not fully concluſive for the real ſolubility of Tin in theſe acids, with regard to the purpoſes for which the chemiſts have wanted ſuch a ſolution; but they prove what is more important, that Tin or tinned veſſels, however pure the Tin

fluid form, without yielding any concrete Salt, as the combinations of the ſame alcalies with the mineral acids always do. Combined with fixed alcalies, it forms a ſubtile neutral Salt, ſoluble both in water and in Spirit of Wine, commonly called *Terra foliata* or *Arcanum tartari:* The ſame alcalies, combined with other acids into a neutral Salt, are not acted upon in the leaſt by vinous ſpirits—— For this and other like purpoſes, diſtilled Vinegar is made choice of, not only as being ſtronger, but purer from Oil and groſs matter, than Vinegar undiſtilled. VINEGAR.

To prepare the *Terra foliata tartari* in perfection, requires ſome nicety. The alcaline Salt is diſſolved in Vinegar, the mixture ſet over the fire in a glaſs veſſel, and more and more Vinegar gradually added during the evaporation, till a freſh addition occaſions no further efferveſcence, and the vapour diſcovers an acid ſmell. The matter is ſtirred during the inſpiſſation till it begins to grow dry; when the fire being raiſed a little, it aſſumes the foliated appearance from which it receives its name. The colour of the Salt is brown or blackiſh: If required white, it muſt be further purified, by ſolution in Spirit of Wine, or by gently and warily calcining it, then diſſolving it in water, and filtering and inſpiſſating the ſolution: If the Salt does not yet prove ſufficiently white, the calcination and ſolution in water are to be repeated. During this depuration, it is neceſſary to examine whether the Salt continues perfectly neutral: If it changes Syrup of Violets green, or a ſolution of green Vitriol turbid, we may be ſure that the alcali prevails; in which caſe, ſome more diſtilled Vinegar muſt be added. There is no danger of exceeding in the quantity of acid: For though an over-proportion of this has been uſed, whatever there is more than ſufficient to neutralize the alcali will be diſſipated in the calcination. Neutral Salt from Vinegar and alcali. Concentrated.

In the *Terra foliata*, *Saccharum ſaturni* and Verdegris, the pure acetous acid is retained, without much phlegm. On diſtilling theſe concretes in a retort, a ſtronger and more concentrated acid ſpirit ariſes, than can be obtained by diſtilling Vinegar by itſelf: This is called *Acetum concentratum* and *radicatum*. Vinegar may be concentrated alſo to a great degree by congelation, the aqueous part freezing, whilſt the acid remains fluid (z). The highly concentrated ſpirit Dulcified.

Tin be, will give a metalline impregnation to light vegetable acids ſuffered to ſtand in them for a few hours.

Gold, Platina, Silver, and Quickſilver are not affected by Vinegar in their metallic ſtate; and theſe are the only metallic bodies that perfectly reſiſt it. Gold and Platina have not been obſerved in any ſtate to be affected by it: Silver precipitated from the nitrous acid and thoroughly edulcorated with water, and Mercury treated in the ſame manner or changed by fire into a red powder, ſlowly and ſparingly diſſolve in it.

Of the affinities of this acid to different metals, or its forſaking one to unite with another, few experiments have been made. I have obſerved only, that it depoſites Lead and Copper upon adding Iron. When Copper is diſſolved in Vinegar, though in ſo ſmall a proportion as ſcarce ſenſibly to diſcover itſelf by the reputedly moſt rigid of all trials, ſtriking a blue colour with volatile alcalies; a poliſhed Iron laid in the liquor contracts a cupreous pellicle, in the ſame manner as from a ſolution of Vitriol of Copper (See page 177.) I have ſeen vegetable acids, at table, give the firſt notice of their having received a pernicious impregnation from Copper veſſels, by leaving a copper-coloured ſtain upon the knife.

(z) *Concentration of Vinegar.*] The concentration of Vinegar by freezing ſucceeds better than that of Wines or vinous liquors.

We

VINEGAR. ſpirit may be dulcified, like the mineral acids, by digeſtion and diſtillation with equal or twice its quantity of rectified Spirit of Wine.

Method of eſtimating its ſtrength. The degree of ſtrength or acidity of Vinegar may be determined, as that of other acids, by neutralizing it with fixed alcaline Salt, and exſiccating the compound: As the alcali retains only the acid part, the increaſe which it has now gained in its weight will give the quantity of acid contained in the Vinegar. In the following experiments, eight drams, or 480 grains, of each of the Vinegars were employed.

Table of the ſtrength of different Vinegars.

	Saturated of fixed alcali.	Weight of the neutral Salt.	Hence the quantity of Acid.	Phlegm.
	Grains.	*Grains.*	*Grains.*	*Grains.*
Spirit of Pale-beer Vinegar	16	24	8	472
Spirit of Brown-beer Vinegar	16	24	8	472
Spirit of Wine Vinegar -	26	38	12	468
Spirit of Verdegris - -	72	120	48	432
Concentrated Vinegar -	270	437	167	313

CLASS II.

Products from Vegetables by Fire.

BY FIRE. THE effect of fire upon vegetable ſubſtances differs greatly, according as the air is excluded or admitted. On diſtillation in cloſe veſſels, all vegetables give over an Oil, not ſuch as it exiſted in the original ſubject, but highly fetid and empyreumatic. Previous to the Oil ariſes a portion of phlegm, and from moſt vegetables an acidulous, from ſome a volatile alcaline ſpirit,

We have formerly ſeen that thoſe liquors, whilſt their watery part freezes, ſuffer a notable alteration in their other principles: The acid of Vinegar is not hurt by the freezing of its phlegm.

By the operations above propoſed, the acetous acid may be concentrated to a degree of ſtrength, in regard to acidity, greater than even the mineral acid ſpirit of Sea-ſalt can eaſily be brought to. It ſtill however retains its ſpecific properties, and continues as different from any of the mineral acids, as they from one another. Its peculiar taſte and odour, its refuſing to cryſtallize with volatile alcalies, its forming with fixed ones a neutral Salt which deliquiates in the air and diſſolves in Spirit of Wine, its parting from the fixed alcali in a moderate fire without any addition, and in ſome degree volatilizing the alcali, its being expelled from alcalies, earths and metals by all the mineral acids, its effects on ſome of the metallic bodies, are ſtriking characters of the acetous acid in all its ſtates of ſtrength.

Some have been accuſtomed to increaſe the acidity of weak Vinegar, by the addition of a certain proportion of the acid of Vitriol. The acid of Vitriol is ſo different, in its effects upon many bodies, from that of Vinegar, that a moſt minute proportion of it is very readily diſcovered. Drop into the liquor a little ſolution of Chalk made in Aqua fortis or Spirit of Salt: If the Vinegar was pure, no change will enſue: If it contained any vitriolic acid, the mixture will become milky in proportion to the quantity of that acid; the vitriolic acid uniting with the diſſolved Chalk into a compound no longer diſſoluble, and which on ſtanding ſubſides in form of a ſelenitic powder.

ſpirit, tainted with the burnt taſte and ſmell of the Oil. In the bottom of the diſtilling veſſel remains a black coal, which, ſo long as the air is excluded, ſuffers no further alteration or diminution in the moſt intenſe fire, but on admitting the air burns into white aſhes with a notable decreaſe of its weight (*a*). By Fire.

Vegetables burnt at firſt in the open air, emit a copious ſmoke, which is manifeſtly impregnated with an acid, and of which a conſiderable part may be collected and condenſed into a black Soot. The aſhes which remain give out to water a portion of fixed alcaline Salt; thoſe vegetables excepted which yield any conſiderable quantity of volatile alcali in the diſtillation, for the aſhes of theſe ſcarcely afford any fixed Salt.

Into theſe principles all vegetables and their parts, and all the ſubſtances extracted from vegetables, are reſoluble; but with ſome differences in regard to the quantities. Thus Gums and Mucilages yield very little Oil, but Reſins abundance: From Gums, Mucilages, Reſins and Oils we obtain very little alcaline Salt; but from the acid eſſential Salts, as that of Sorrel, a large proportion.

EMPY-

(*a*) *Coal, not alterable without air.*] Upon this principle, the method of making Charcoal depends. A quantity of wood, cut in pieces, is piled in a large heap, which is ſet on fire, and lightly covered with Turf, to prevent its burning too violently. When the ſmoke is diſſipated, and the wood reduced into a clear red-hot coal, the whole is immediately covered cloſely over with earth, which, by excluding the external air, prevents the coals from being any farther conſumed. When the proceſs is ſkilfully managed, the coals exactly retain the figure of the pieces of wood: Some have been ſo dextrous as to char an arrow, without altering the form even of the feather---- Pitcoal alſo is for ſome purpoſes advantageouſly charred; as for the drying of Malt, and the ſmelting of metals; the ſuliginous and ſulphureous parts, which would give a taint to the one and brittleneſs to the other, being thus diſſipated, whilſt the more pure and fixed igneſcible matter is left.

There are conſiderable differences in the coals of different vegetables, in regard to their habitude to fire. The very light coals of Linen, Cotton, ſome Fungi, *&c.* readily catch fire from a ſpark, and ſoon burn out: The more denſe ones of woods and roots, are ſet on fire more difficultly, and burn more ſlowly. The coals of the black berry-bearing Alder, of the Hazel, the Willow, and the Lime-tree, are ſaid to anſwer beſt for the making of Gunpowder and other pyrotechnical compoſitions; perhaps from their being eaſily inflammable. For the reduction of metallic calces, thoſe of the heavier woods, as the Oak and the Beech, are preferable; theſe ſeeming to contain a larger proportion of the phlogiſtic principle, and that perhaps in a more fixed ſtate. Conſidered as common fuel, thoſe of the heavy woods give the greateſt heat, and require the moſt plentiful ſupply of air to keep them burning: Thoſe of the light woods preſerve a glowing heat, without much draught of air, till the coals themſelves are conſumed: The bark commonly crackles and flies about in burning, which the coal of the wood itſelf very ſeldom does.

Coals are indiſpoſed to putrefy: Hence the ends of wooden poſts, to be fixed in the earth, are charred on the outſide to preſerve them from rotting. Neither water, vinous ſpirits, Oils, acid or alcaline liquors, diſſolve or extract any tincture from them. In burning, they are ſuppoſed to emit a peculiar vapour, which, confined and accumulated in a cloſe room, proves poiſonous to animals: There are indeed too many examples of fatal conſequences from the burning of Charcoal in cloſe places; not however from the Charcoal giving out any pernicious matter, but from the quality of the air of the room being altered by the fire. Air that has paſſed through burning fuel is no longer capable of ſupporting either fire or the life of animals.

EMPYREUMATIC OILS.

Emp. Oils.

Diſtillation of empyreumatic Oils.

THE diſtillation of empyreumatic Oils is performed in earthen retorts or long-necks, or in coated glaſs ones. The fire muſt be ſtrong, but ſlowly raiſed; and the juncture of the retort and recipient but ſlightly luted. Vegetable ſubſtances in general, urged haſtily by a ſtrong fire, emit an aereal elaſtic vapour, which, if no exit is allowed it, throws off or burſts the receiver. Reſinous ſubſtances ſwell and boil up in the fire: It is cuſtomary to mix with theſe a quantity of Sand or other earthy matters to prevent their boiling over, though by carefully regulating the heat, the diſtillation may be commodiouſly performed without any ſuch addition. The Oil which ariſes at firſt is commonly fluid, and ſwims upon the phlegm and ſpirit that preceded it: That which follows proves more and more thick and heavy, and ſuch as is forced out at laſt by the greateſt vehemence of fire aſſumes a pitchy conſiſtence.

Their general properties, and differences from eſſential Oils.

The Oils obtained from vegetables by this proceſs differ remarkably from the eſſential ones diſtilled with water. Even after their ſeparation from the ſubject, they do not ariſe in the heat of boiling water, or at moſt only the finer and more ſubtile parts are elevated by that heat. They have a very diſagreeable burnt ſmell and taſte, and a great degree of acrimony, without any thing of the peculiar flavour or other qualities of the vegetable they were drawn from. The moſt inodorous and inſipid expreſſed Oils, as Oil Olive and Oil of Almonds, diſtilled by a ſtrong fire, become in like manner fetid and acrimonious; and eſſential Oils themſelves, by a like treatment, loſe their ſpecific flavours, and contract an empyreumatic taint.

Empyreumatic Oils diſſolve in Spirit of Wine rather more eaſily than the eſſential (*b*); they are likewiſe more diſpoſed to unite with water, probably from their

(*b*) *Solubility of Oils in Spirit of Wine.*] It is obſervable, that the eſſential Oils obtained from different vegetable matters, diſſolve with different degrees of facility in Spirit of Wine: That all of them, as firſt diſtilled, diſſolve more eaſily than after they have been rectified; and that on every rectification, or rediſtillation, they become leſs and leſs diſſoluble, whilſt the reſinous reſiduum diſſolves more eaſily than the Oil at firſt. Expreſſed Oils, on the other hand, in their natural ſtate, are not ſoluble in vinous ſpirits at all: Diſtilled, or rendered empyreumatic by fire, they acquire a degree of ſolubility; and on repeated diſtillations they become eaſier and eaſier of ſolution. Theſe Oils are likewiſe made ſoluble in ſpirit, by being combined with alcaline Salts into Sope, and afterwards ſeparated from the alcali by the addition of any acid.

Mr. Macquer, in the French Memoirs for the year 1745, endeavours to account for theſe different phænomena---Spirit of Wine, as we have formerly ſeen, conſiſts of a ſubtile attenuated Oil combined with water: It contains alſo an acid principle, and poſſibly it is by means of this acid that the Oil is combined with the water. The ſoluble eſſential Oils are found to participate of an acid; and the admixture of Oil of Vitriol or Spirit of Nitre renders thoſe Oils ſoluble in ſpirit which of themſelves are not. Mr. Macquer is hence led to ſuppoſe, that Oils are more or leſs ſoluble, in proportion as they contain more or leſs of a manifeſt acid. Eſſential Oils, rectified, become leſs ſoluble by loſing a part of their acid; and the reſiduum proves more ſoluble, by retaining the acid which the Oil has loſt. Expreſſed Oils are indiſſoluble, becauſe their acid is latent, or too intimately combined with the other principles to exert its activity:

their participating more of an acid principle. By careful rediſtillations they become more ſubtile and volatile, and loſe much of their fetid ſmell, a large proportion of groſs matter being left behind: I have rectified an empyreumatic Oil to ſuch a degree, that one could not eaſily determine what kind of ſubſtance it was: It mingled with almoſt all ſorts of liquors, with expreſſed Oils, diſtilled Oils, Spirit of Wine, Vinegar, and Water. EMP. OILS. Rectification.

The rectification of theſe Oils is uſually performed with the addition of Aſhes, burnt Hartſhorn, Quick-lime, fixt alcaline Salts, and other ſubſtances, which are ſuppoſed to make the purification more perfect by detaining the groſſer matter. There is no occaſion for any aſſiſtances of this kind: It is ſufficient to waſh the Oil with warm water, put it into a retort with freſh water, diſtil by a gradual fire till the fluid part is come over, and repeat the ſame proceſs with the Oil that diſtils: Every repetition renders it more and more ſubtile, and proportionably diminiſhes its quantity. The water, which ariſes before the Oil, is impregnated with a part of it——When fixed alcaline Salts are employed in the rectification, a portion of volatile alcali is generated: When Quick-lime or calcined Hartſhorn, the Oil, by repeated diſtillations, is totally deſtroyed.

S O O T.

THOUGH the ſmoke of wood is apparently acid, the Soot has no acidity: Inſtead of yielding an acid in diſtillation, as wood itſelf does, it yields a volatile alcali; together with an empyreumatic Oil like that obtained from vegetables entire. Oils themſelves, whether empyreumatic, eſſential or expreſſed, afford a Soot in burning; and this ſoot is reſoluble into the ſame principles as that of wood. The coal remaining after the diſtillation of Soot burns into white aſhes, from which may be obtained a fixt alcaline Salt, as from other vegetable aſhes. Some of the chemiſts have ranked Oil as one of the elementary SOOT. Its differences from vegetables entire, and from their ſmoke.

vity: Fire makes them ſoluble, and more and more ſo, by extricating this acid, and by extricating more and more of it in every diſtillation: Alcalies alſo call forth their latent acid and on adding to this compound any other acid, the Oil with its acid ſeparates (in the ſame manner as Sulphur diſſolved in alcalies) and of courſe diſſolves in ſpirit. The ſame theory is applied alſo to reſinous ſubſtances, for all Reſins yield a little acid in diſtillation: Where he finds a Reſin that diſſolves eaſily in Spirit of Wine, its acid is manifeſt or but looſely combined: In thoſe which diſſolve difficultly, the acid is latent, or enveloped in the other matter.

This theory is plauſible and ingenious, but a competency of experiments is as yet wanting to enable us to determine how far it is juſt. There is wanting, for inſtance, ſome direct evidence, that an acid is really extricated from expreſſed Oils, by making them into Sope, or by fire; for the filaments of the torn edges of blue paper being ſtained of a reddiſh-yellow colour by the fumes of boiling Oil, can ſcarcely be depended on as a teſt of acidity. There is wanting more particularly ſome proof that theſe Oils are capable of being made diſſoluble in ſpirit by the admixture of any vegetable acid; for their being ſo by the concentrated mineral acids does not ſeem to be ſufficient, eſpecially as theſe acids, at the ſame time that they render the Oil diſſoluble, change its nature, and convert it into a ſubſtance of a different kind. It ſeems hard to admit that animal Oils contain an acid; and yet theſe Oils diſſolve as well as the vegetable, in Spirit of Wine.

SOOT. tary parts of bodies; but it cannot ſurely be looked upon as an element, when it is convertible or reſoluble into an aqueous or acid vapour and Soot, and this Soot further reſoluble into Water, Oil, volatile Alcali, fixed Alcali and Earth.

Differences in Soots. The Soots produced from different vegetable ſubſtances, from green and dry ones, from open and more confined fires, differ in regard to the proportion, but not in the quality, of the principles they afford.

Analyſis by fire. Sixteen ounces of the common Wood-ſoot of Berlin yielded a dram of volatile alcaline Salt, ſeven drams of Oil, and a dram and a half of fixed Alcali: The ſame quantity of French Wood-ſoot gave upwards of two ounces of Oil, a dram of volatile Alcali, and four drams of fixed. The volatile Salt is very difficultly purified from the fetid Oil, more ſo than thoſe of animal ſubſtances. It is ſaid that the Oil, rectified with Hartſhorn or Vinegar, acquires a ſmell like that of Camphor; but I have not been able, on careful trial, to perceive any ſuch ſmell. It is obſervable that a mixture of Soot and Salt of Tartar, digeſted for ſome months with the juice of the Birch-tree, that is, the liquor which iſſues upon boring the tree early in the ſpring, yields on being diſtilled a liquor of a beautiful, but not very durable purpliſh-red colour: With common water no ſuch colour is produced.

Analyſis by menſtrua. The bitter matter of Soot, and that part in which its ill ſmell reſides, are diſſolved and extracted both by watery and by ſpirituous menſtrua. On digeſting ſixteen ounces of Soot in rectified Spirit of Wine, and evaporating the tincture, the dry extract amounted to four ounces: The ſame quantity, treated in the ſame manner with water, yielded juſt as much. The Soot remaining after the action of either of theſe menſtrua, yields with the other about two ounces and five drams.

Uſes. Soot is employed ſometimes medicinally as an antihyſteric, *&c.* and in operations on ſome metallic bodies. It is to the action of a ſooty flame, that the red colour of Minium is owing: From a ſooty flame, the ruby and ſome other glaſſes receive their colour. [See pag. 38, 51.] The finer parts, ſeparated by means of water, are uſed as a Pigment, under the name of Biſtre. Boiled with woollen cloth, it communicates a brown dye, and in this intention is ſometimes employed by the dyers. The ſubſtance called Lamp-black is no other than a vegetable Soot, produced in the burning of Reſins.

FIXT ALCALINE SALTS.

FIXT ALCALI. FIXT alcaline Salts, called alſo Lixivial ſalts, are extracted from the aſhes of vegetables, by macerating or boiling them in water, ſtraining or filtering the Ley, and evaporating it till the Salt remains dry. If the aſhes have not been thoroughly burnt, the Salt appears brown coloured and foul: By calcination, and rediſſolution it becomes pure and white (*c*). If the ſolution be evaporated

Preparation of fixt alcalies.

(*c*) *Preparation of fixed Alcalies.*] The moſt commodious method of preparing fixed alcaline Salts in the large way ſeems to be that directed by Kunckel in his Art of Glaſs. The aſhes of wood or the woody parts of vegetables, either burnt on purpoſe or as common fuel, are to be put into a large tub or vat, whoſe bottom is covered with pieces of ſplit wood and ſtraw to prevent the aſhes from ſtopping up the cock. So much water is to be poured on the aſhes as may totally cover them: After ſtanding for

FIXT ALCALI.

for a night, the liquor, impregnated with their ſaline part, is to be let off by the cock at the bottom into another veſſel; and the elixation repeated with freſh water ſo long as the Ley has any ſaline taſte. The elixated aſhes may be uſed, like common wood-aſhes, for manure; and the weak Leys may be rendered ſtronger, by pouring them, inſtead of plain water, upon a freſh quantity of aſhes. Thus from every parcel of aſhes we obtain a ſtrong Ley, with a weaker one to be returned on the next. Where the Ley is to be kept in its liquid ſtate, wooden veſſels (according to him) are more commodious than earthen ones however glazed; theſe laſt being ſoon corroded and penetrated by the acrid liquor.

For procuring a ſolid Salt, the Ley is to be evaporated in an iron pan fixed in brick-work; freſh Ley being continually ſupplied during the evaporation, in a very ſlender ſtream, from a caſk placed on the brick-work, till the quantity of Salt is as large as can be conveniently dried in the veſſel. This impure brown or blackiſh Salt is to be calcined, in a furnace built for that uſe, with a red heat juſt not ſtrong enough to melt it, and every now and then turned up and ſtirred, for ſix or ſeven hours, or till ſome of the larger pieces, taken out and broke, appear internally white. Thus we obtain an Alcali ſufficiently pure for all the buſineſſes in which theſe kinds of Salts are employed: If for particular purpoſes a further purification ſhould be required, it may be diſſolved, inſpiſſated, and calcined afreſh. The rough Salt loſes, in the firſt calcination, commonly about one tenth of its weight.

Some ſoak in the Ley a quantity of Straw, Bean-ſtalks or other like ſubſtances, ſufficient to imbibe it; and by drying, and burning theſe, obtain the Salt of the Ley, without the trouble of boiling it down. The earthy matter left by the Straw is, in quantity inconſiderable, and for many purpoſes, of no injury to the Salt, particularly for ſope-boiling, bleaching, *&c.* where the Salt is diſſolved, and conſequently purified from indiſſoluble earthy admixtures, before it is uſed. There is nevertheleſs one great inconvenience in the proceſs; the Straw, when loaded with the Alcali, being very difficultly made to burn. Vegetable ſubſtances in general, when fully impregnated with fixed alcaline Salts, never flame; and do not burn at all without a continuance of external heat; inſomuch that ſome have propoſed the impregnating of wood, for buildings, with Salts, as an effectual means for preventing its receiving or communicating fire.

The ſtrength of Leys, or the quantity of Salt diſſolved in them, may be eſtimated by the weight of a certain meaſure of them, compared to the weight of an equal meaſure of water; or more commodiouſly, and perhaps as accurately, by means of an hydrometer graduated from actual trials with Leys of known ſtrength.

I have made ſeveral experiments for determining the ratio in which alcaline Salts increaſe the gravity of water; with a view to enable the workman to judge with ſome preciſion, from the weight of the Ley, the quantity of Salt that may be expected from it on evaporation. I diſſolved in pure water different proportions of fixed alcaline Salt, and weighed very carefully equal meaſures of the ſeveral ſolutions, in a narrow-necked glaſs, which held ſixteen ounces of water: A mark was made in the neck with a diamond at the part where this quantity of water aroſe to, and the bottle filled to the ſame height with each of the other liquors. The reſult of the experiments was as follows.

When 16 ounces of the liquor, by weight, contained of Salt,		The meaſure of the liquor weighed more than 16 ounces, or more than an equal meaſure of water, by		
Oz.	*Dr.*	*Oz.*	*Dr.*	*Gr.*
0	4	0	1	40
1	0	0	3	30
1	4	0	5	00
2	0	0	7	30
2	4	1	1	30
3	0	1	3	30
3	4	1	5	00
4	0	1	7	20
4	4	2	1	22
5	0	2	3	25
5	4	2	5	02
6	0	2	7	30
6	4	3	1	30
7	0	3	3	28
7	4	3	5	01
8	0	3	7	30
8	4	4	1	30

The weights here made uſe of were the Troy, of ſixty grains in the dram, and eight drams in the ounce.

Fixt Alcali.

porated only till a pellicle begins to concrete upon the ſurface, then put into a glaſs body, covered ſo as to prevent the falling in of duſt, and ſet by in a moderately warm place, part of the Salt will ſhoot into cryſtals; and if the remaining liquor be further evaporated to a pellicle, and ſet by as before, more cryſtals will be obtained. Some have held theſe cryſtallized Salts to be more pure than ſuch as are directly inſpiſſated to dryneſs: But in reality they are more impure; fixed alcalies never aſſuming a cryſtalline form, but in proportion as they participate of an acid. If a perfect Alcali is required, we ſhould reject the cryſtals, and employ only the Salt procured by inſpiſſation from the liquor remaining after the cryſtallization.

Different ſorts. Soda.

Fixt alcaline Salts were originally prepared from the aſhes of the plant Kali, and from hence they are ſuppoſed to have received their name. Kali or Soda is a maritime plant; and its aſhes contain, beſides the truly alcaline Salt, a portion of Sea-ſalt (*d*). It has been found that fixed alcalies are conſtantly the ſame, whatever ſubject they have been produced from: Hence at preſent, they are

Theſe experiments agree very nearly in the ſame ratio. We may draw from them this general rule, that the weight, by which any meaſure of Ley exceeds the ſame meaſure of water, is ſomewhat leſs than one half (or about five twelfths, of the quantity of Salt contained in a meaſure of the Ley.

(*d*) *Soda.*] Soda, the impure Salt of Kali or Glaſswort, ſometimes brought to us from Spain, appears to contain no actual marine Salt, or only an inconſiderable proportion. The ſaline part however, when purified from the earthy matter which is uſually in large quantity, approaches in ſome reſpects to the nature of that Salt, and differs remarkably from all the other known vegetable alcalies.

On gently evaporating ſolutions of it, the Salt concretes into cryſtalline maſſes, which do not liquefy, nor ſoon grow moiſt in the air. The cryſtals change Syrup of Violets green, render Sulphur and Oils ſoluble in water, effervеſce with all acids, precipitate earthy and metallic bodies diſſolved in them, and unite with the acid into a neutral Salt; proofs, that notwithſtanding their cryſtalline appearance, they are truly alcaline.

When this Alcali is combined with the acetous acid, the neutral compound is found to be nearly ſimilar to that compoſed of the ſame acid and the common alcalies; but in combination with the mineral acids, the caſe is different. With the vitriolic it forms, not like other alcalies a vitriolated Tartar, but a Sal mirabile; with the nitrous, not common Nitre, but a Nitre which cryſtallizes into cubes; with the marine, a perfect Sea-ſalt; proofs, that the Alcali of Soda is the ſame with the alcaline baſis of Sea-ſalt, but wants its acid. (See the reſpective Salts in the firſt part).

The Kali itſelf appears to contain actual Sea-ſalt. Stahl informs us, that its taſte is manifeſtly brackiſh, and that in ſome places it is uſed inſtead of common Salt. Henckel, in the Appendix to his *Flora ſaturnizans*, gives a more convincing proof: By boiling the herb in water, and evaporating and cryſtallizing the decoction, he obtained a true marine Salt, and in conſiderable quantity.

The laſt mentioned author diſcovered a pretty remarkable phænomenon in treating both the Spaniſh Soda, and the Salt elixated from the aſhes of the German jointed Kali, with the mineral acids. On ſaturating either of theſe Salts with any of the acids, a deep blue powder fell to the bottom, ſimilar to Pruſſian-blue, and which anſwered equally in painting. He obſerves, that the quantity of this powder is very ſmall, amounting only to about five grains from an ounce of the Salt; and that it is largeſt when the vitriolic acid is uſed: That with diſtilled Vinegar there was no precipitation; with dulcified Spirit of Nitre, only a browniſh one.

The Spaniſh Soda was formerly in great requeſt for making Glaſs. Kunckel obſerves, that when duly purified, it proves

for

are made chiefly from ſuch ſubjects as are moſt plentiful, and afford them in greateſt purity and in greateſt quantity. A Salt is ſtill indeed in ſome places prepared from Kali, and employed by the glaſs makers, dyers and ſope-boilers; but thoſe commonly met with in the ſhops, under the name of Pot-aſh, are obtained from the aſhes of different kinds of wood, particularly the hard ones: They are made chiefly in the woody countries, Muſcovy, Poland, Courland; *&c.*

FIXT ALCALI.

Pot-aſh.

The common Pot-aſh is not a pure alcaline Salt, any more than the Salt of Soda. It contains a conſiderable portion of mere earth, ſeparable by diſſolving the Salt in water (*e*). It contains alſo a neutral Salt, whoſe acid is manifeſtly the vitriolic, for on being melted with powdered Charcoal, it produces a true Sulphur. Did this acid exiſt originally in the wood? Was it communicated, during the burning, by the air, whoſe paſſage through the fuel is abſolutely neceſſary to the ſupport of fire, and of which immenſe quantities muſt be

Contain a neutral Salt.

for that purpoſe equal, but not ſuperior to other alcaline Salts; that Glaſs made with Soda in the impure ſtate in which it is brought over, is exceeding apt to crack or fly in cooling, and has likewiſe a bluiſh caſt, which, if we endeavour to clear it by the addition of Manganeſe, changes to a blackiſh or a greeniſh---Stahl on the other hand, gives the preference to Soda. He admits that Pot-aſh yields a finer Glaſs; but ſays the Glaſs prepared with Pot-aſh has this capital defect, that if it has not been kept in the fire till the Salt is burnt *dead* as he calls it, veſſels made of it crack after they have been wetted, and large pieces fly out of them; the unmortified or unconſumed Salt beginning to diſſolve, ſo as to deſtroy the coheſion of the Glaſs. We apprehend that this imperfection proceeds rather from a redundance in the quantity, than from any particular quality of the Salt made uſe of.

(*e*) *Pot-aſh.*] There are two principal ſorts of theſe Salts brought chiefly from Germany, Pearl-aſh, and Pot-aſh. The Pearl-aſh is either of the whitiſh Pearl colour from which it receives its name, or externally of a bluiſh caſt, which theſe kinds of Salts are apt to receive in calcination from the contact of any inflammable matter. Both the Pearl-aſhes are tolerably pure alcalies: Diſſolved in water, or deliquiated in the air, they leave only a ſmall quantity of earthy matter, ſcarcely more than every alcaline Salt does upon repeated ſolutions and calcinations. They are ſometimes, however adulterated with heterogeneous ſaline matters, particularly Sea-ſalt. The purity of Pearl-aſh from ſubſtances of the earthy kind points out the method in which it has been prepared, namely, evaporating a Ley of vegetable aſhes till the Salt remains dry.

Pot-aſh is a much more impure ſaline maſs: That called Ruſſia or Muſcovy Pot-aſh is accounted the beſt. This is of a dark colour, conſiderably hard, and does not eaſily grow moiſt in the air: On boiling it in water, a quantity of earth remains undiſſolved, much larger than that of the Salt which is extracted. It is nevertheleſs found to be ſtrongly alcaline, to be more pungent to the taſte, to ſaturate more acid, and more powerfully to diſſolve Oils, than the purer alcaline Salts: Hence it is preferred by the Sope-boiler.

This Salt is ſaid to be prepared, by burning wood with a cloſe ſmothering heat; making a Ley from the coarſer part of the aſhes, and moiſtening therewith the finer part into the conſiſtence of a paſte, ſtratifying this paſte with ſome of the more inflammable kinds of wood, and ſetting the pile on fire---It is not improbable, that the ſaline and earthy part of the aſhes would thus run together into hard lumps; but a maſs poſſeſſing the activity of Ruſſia Pot-aſh is not to be obtained by any proceſs of this kind. For the diſcovery of the ingredient on which that quality depends, we are obliged to Dr. Home, who, in his eſſay on bleaching, has proved, by a number of curious experiments, that Ruſſia Pot-aſh contains a large admixture of Quick-lime.

Fixt Alcali.

be conſumed by the large piles uſually burnt at once for the making of Pot-aſh? Or was it imbibed from the water employed for the elixation of the Salt? Perhaps it may proceed in part from all the three ſources.

The neutral Salt in Pot-aſh, whatever be its origin, is ſimilar in its properties to vitriolated Tartar. (See page 190.) It is ſcarcely acted upon by cold water, diſſolves difficultly in hot water, and in great part ſeparates again as the ſolution cools. Hence the alcaline Salt may be purified from the neutral, by ſolution in hot water, and after evaporation to a pellicle, ſetting the liquor to ſhoot; or more effectually, by employing cold water, which will diſſolve the alcaline, and leave the neutral Salt behind. The purification will ſtill be more perfect, if the inſpiſſated Salt be run per deliquium, for no part of the neutral Salt will deliquiate in the air.

Purification.

Differences in the common alcalies.

It is owing to the admixture of this vitriolic or other neutral Salts, or to a part of the inflammable or oily principle of the ſubject being retained in the Salt, from the aſhes not having been perfectly burnt; that different alcaline Salts, exhibit in ſome experiments, different phænomena. Hoffmann obſerves, that when Oil of Vitriol is poured upon Salt of Tartar, the liquor acquires a blackiſh ſkin on the ſurface, appears itſelf alſo blackiſh, and emits a particular fetid ſmell; but that nothing of this happens when Pot-aſh is uſed; that Salt of Tartar, melted with ſand, does not form a clear and tranſparent Glaſs, which Pot-aſh does; and that Salt of Tartar gives a tincture to highly rectified Spirit of Wine, which Pot-aſh does not. Theſe experiments prove, not that the two Salts differ from one another as alcalies, but that one retains a part of the Oil of the ſubject, and the other not. When Tartar is deflagrated with a due proportion of Nitre, its Oil is wholly burnt out, and the alcaline Salt thus obtained, equally with Pot-aſh, forms a clear Glaſs with ſand, produces no blackneſs with Oil of Vitriol, and gives no tincture to rectified ſpirit. The ſame author finds however that there is now another difference; that Pot-aſh, and the Salt made from Tartar alone, on being melted with Charcoal powder, form a ſulphureous compound, whilſt the Salt from Tartar and Nitre has no ſuch effect: The cauſe is obviouſly this, that the two former contain a portion of the vitriolic Salt above-mentioned, and the latter not.

All ſimilar when pure.

In ſhort all the alcaline Salts, when perfectly pure, are one and the ſame thing: From one vegetable we obtain Salts as different, according as the aſhes have been more or leſs calcined, elixated with hot or with cold, with a large or a ſmall quantity of water, *&c.* as we do from different ones; the differences obſerved in the Salts, where any differences are obſerved in them, depending upon the manner in which the proceſs has been managed, and not upon the qualities of the ſubject. No art can diſtinguiſh the fixt alcaline Salts of the ſweet plants from thoſe of the bitter or the ſour; of the purgative from the aſtringent; of the higheſt cordials and aromatics from thoſe of the moſt deadly poiſons (*f*).

Fixt

(*f*) *Identity of fixed alcaline Salts.*] In regard to this point, fixed alcaline Salts are to be conſidered in two ſtates; that in which they are prepared by the workman for common uſes, by incinerating the plant, elixating the Salt from the aſhes, and evaporating the Ley; and that of their ultimate purity, obtained by repeated calcinations with a ſtrong

Fixt alcaline Salts ſeem to be produced from a combination of the groſſer acid and a part of the earth of the ſubject, and perhaps a little of the more fixed inflammable principle, effected by the fire. The eſſential Salt of Sorrel is a truly acid Salt, totally ſoluble in water. An ounce of this Salt, diſtilled in a glaſs retort, gave over about a ſcruple of Oil, and three drams of phlegm ſlightly impregnated with a volatile acid, certainly not all the acid that the Salt contained: The reſiduum weighed four drams twenty grains, and from this were obtained three drams of perfect alcaline Salt. If fixed alcalies be calcined, deliquiated in the air, the liquor inſpiſſated, and the deliquiation and inſpiſſation ſeveral times repeated, a quantity of earthy matter will ſeparate every time, till at length nothing but earth is left. The perfect inſpiſſation, however, cannot be continued long: After a number of repetitions, the liquor cannot be reduced to a dry ſtate, but retains nearly the conſiſtence of Oil of Vitriol: Expoſed to the fire in a crucible, it diſſolves or penetrates it.

FIXT ALCALI. Their production.

Vegetable ſubſtances which abound moſt with acid, are thoſe which yield moſt fixed Alcali; and thoſe from which no acid is ſeparable by diſtillation, are thoſe which yield no fixt alcaline Salt. When vegetables that do abound with acid are burnt with a cloſe ſmothering heat, greateſt part of the acid is gradually

a ſtrong fire, and deliquiations in the air. In this laſt ſtate, all fixed alcaline Salts (the marine alcali excepted) are perhaps one and the ſame thing; at leaſt the experiments hitherto made diſcover no diverſity in them. But in the firſt ſtate, the Salts of different plants exhibit, on ſundry trials, differences too conſiderable to be overlooked by the artiſt or by the philoſopher.

Mr. Gmelin has given a great number of experiments on this ſubject in the fifth volume of the *Commentaria Petropolitana*. The Salts of the ſeveral plants examined were prepared with great care, and all of them exactly in the ſame manner, each vegetable being burnt, in a ſeparate crucible, with the ſame degree of fire, till no remains of coaly matter could any longer be perceived; and the aſhes elixated in glaſs veſſels, with cold diſtilled water. The Salts, thus obtained, were found to produce different colours on mixture with certain liquors, and to effervеſce in very different degrees with acids: Certain metallic ſolutions were by ſome precipitated, by others only rendered thick, by others both precipitated and thickened, whilſt others occaſioned neither one or the other of theſe changes, and left the liquor fluid and tranſparent. Thus, with the vitriolic acid, the Salts of Southernwood and Sage ſtruck a pale brown colour; thoſe of Pine-tops and Rue, a yellow; that of Fern, a reddiſh-yellow; and that of Sanicle, a dark Leek green: That of Dill yielded a Leek green Precipitate, with elegant green flakes floating in the liquor. This laſt Salt gave a greeniſh Precipitate alſo with the marine acid, and a red one with the nitrous. Solution of corroſive Sublimate was changed yellow by Salt of Southernwood; of a browniſh Saffron colour by that of Coltſfoot; of a deep red by that of Wormwood; and of a Pitch colour by that of Dill: That of Fern threw down an opal coloured, of Sage a Sulphur yellow, of Elder-flowers a Citron yellow, of Sanicle a Saffron coloured, and of Milfoil a deep red Precipitate. From ſolution of Silver, Salt of Carduus benedictus threw down a white, of Camomile a grey, of Hyſſop a browniſh, of Dill a blackiſh-brown, of Scabious a yellowiſh, and that of Pine-tree tops a Sulphur yellow Precipitate. Solution of Vitriol of Copper was changed by Salt of Southernwood to a bright ſea-green, by that of Dill to an unſightly green, of Agrimony to a greeniſh-blue, and by that of Milfoil to a bright ſky-blue: The Salt of Pennyroyal made the liquor thick as well as blue, and that of Feverfew made it thick and green: The Salt of Hyſſop threw down a green Precipitate, that of Scurvygraſs a blue one, and that of Fumitory a greeniſh blue; whilſt the Salt of Fern made ſcarcely any change either in the colour or conſiſtency of the liquor.

FIXT ALCALI.

gradually diſſipated, and very little Alcali is produced: In a quick open fire, the acid is intimately coagitated with the earth before the diſſipation can happen, and the produce of Alcali is vaſtly larger: What a minute proportion does Charcoal yield, compared to that obtainable by burning the wood at firſt in an open fire! Rotten wood affords little or none.

That the oily matter of the ſubject contributes alſo to the formation of the Alcali, either by furniſhing a material principle to the compound, or by ſerving, when on fire, as a medium for the coagitation and combination of the acid with the earth, appears from hence, that no alcalies are producible but from ſubſtances that contain Oil, and by ſeparating their Oil we diminiſh their produce of Alcali, though not ſo much as by ſeparating their acid. From ſixty-four ounces of dry Wormwood were obtained about two ounces and a half: The ſame quantity, digeſted in Spirit of Wine ſo long as the menſtruum continued to extract any tincture, yielded but one ounce; and when digeſted in water as well as in ſpirit, only nineteen or twenty grains.

Whether obtained in greateſt quantity from freſh or dry plants.

Tachenius and ſeveral others affirm, that plants burnt whilſt freſh, afford much more Salt than if they are previouſly dried: Rivinus, on the other hand, found from experiment, that the yield was in both caſes the ſame. Both theſe obſervations are in certain circumſtances juſt, but neither of them univerſally ſo. In ſome vegetables, the acid principle is of a ſubtile volatile kind, or looſely blended with the other parts, ſo as to exhale in drying: In others, it is groſſer or more intimately combined, and ſuffers no waſte in the exſiccation. The firſt yield moſt Alcali if burnt freſh; the latter yield juſt as much when dried——Some vegetables, however carefully burnt, loſe their acid in the proceſs, and afford very little Alcali: Guaiacum wood for inſtance. Nevertheleſs, if an extract be made from Guaiacum with water, and this extract gently burnt along with the remaining wood, the aſhes thus obtained will yield on elixation a conſiderably larger quantity (*g*).

Their diſtinguiſhing characters.

Fixed alcaline Salts are diſtinguiſhed from ſaline ſubſtances not alcaline, by their effervеſcing with all acids, forming with them neutral Salts, precipitating ſolutions made in acids, and changing Syrup of Violets green. They are diſtinguiſhed from volatile alcalies by their fixity (*h*) and fuſibility in the fire, by their

(*g*) *More Alcali from the extract*, &c.] Mr. Bourdeline informs us (in the Memoirs of the French Academy for the year 1730) that this experiment ſucceeded with him in a different manner. Six pounds, he ſays, of ſhavings of Guaiacum gave one hundred and thirty grains of fixed alcaline Salt: The ſame quantity, after having been boiled in water for twelve hours, gave ſeventy-eight grains; the decoction, inſpiſſated and calcined, only forty-ſeven grains; ſo that here, the extract and the remaining wood did not yield ſo much as the ſame quantity of the wood burnt directly. But it muſt be obſerved, that our author requires the extract and the remaining wood to be burnt *together*, whereas Mr. Bourdeline burnt them *ſeparately*. The fire is required alſo to be *gentle*; a circumſtance which does not a little influence the produce of the Salt, and which in this experiment was not perhaps attended to. I cannot however take upon me to determine whether the yield is largeſt in one or the other caſe.

(*h*) *Fixity in the fire.*] Though theſe Salts, by themſelves, bear a conſiderably ſtrong fire, without any remarkable diſſipation, and give over nothing on being diſtilled in cloſe veſſels, they are far from being abſolutely fixed. They evaporate plentifully in the glaſs-houſe furnace; and by the admix-

their deliquiating in the air and never aſſuming a cryſtalline form, changing ſolution of Mercury-ſublimate not white but of an orange-yellow, producing no blue colour with Copper or its ſolutions, raiſing no viſible cloud when placed near an unſtopt bottle of Spirit of Nitre, occaſioning no coldneſs but rather heat on being diſſolved in water. Pure fixed alcalies, diſſolved in water, mingle with a ſolution of any other pure Alcali, without the leaſt precipitation, turbidneſs, or ſenſible change. FIXT ALCALI.

Fixt alcalies diſſolve Sulphur, Oils, Fats, and reſinous bodies. By Quick-lime their activity is increaſed (*i*), and in this ſtate they diſſolve ſome metallic ſubſtances, as Calces or filings of Lead, fine filings of Copper, Copper precipitated Conſidered as menſtrua.

ture of certain other ſubſtances they are in part volatilized in a very gentle heat; in a heat no greater than that in which rectified Spirit of Wine diſtils, and the volatile Alcali of Sal ammoniac ſublimes. In effect, when Spirit of Wine is rectified by diſtillation from fixed alcalies, it always carries up with it a portion of the Alcali; and when the volatile Salt of Sal ammoniac is extricated from its acid by the ſame intermedium, it elevates in ſublimation a much larger quantity: See page 221.

(*i*) *Activity increaſed by Quick-lime.*] For this purpoſe, equal parts of Quick-lime and fixt alcaline Salt are gradually ſprinkled with ſo much water as will ſlake the Lime: More water is then added, the whole ſtirred together, and ſuffered to ſtand for a day or two. The liquor, poured off clear from the undiſſolved Lime, is the common Sope-ley. The College of London direct their Ley, for making their Almond Sope, to be of ſuch a ſtrength, that an exact wine-pint may weigh juſt ſixteen ounces troy: If it is heavier, for every dram that it exceeds this weight, an ounce and a half of water, by meaſure, is to be added to each pint of the liquor: If lighter, it is to be boiled till the like quantity is waſted, or poured upon freſh Lime and aſhes. The Sope-boilers make their Ley conſiderably ſtronger: A wine-pint commonly weighs above ſeventeen ounces, or about one eighth more than a pint of water.

As theſe Leys are much more acrimonious, and more active menſtrua, than ſolutions of fixed alcaline Salts by themſelves; they retain alſo a proportionably greater degree of activity, when evaporated to a dry Salt. The Salt is ſo corroſive, as not to be ſafely touched with the tongue: Applied to the ſkin, it quickly produces a ſolution of continuity, and hence is commonly made uſe of as a Cauſtic. Some prepare the Cauſtic by adding a quantity of Lime in ſubſtance towards the end of the evaporation of the Ley: This addition renders it leſs apt to liquefy and ſpread upon the ſkin, but at the ſame time leſs ſpeedy in its effect.

Experiments have not diſcovered, that the cauſtic Salt retains any part of the Lime made uſe of in the preparation of the Ley: The Alcali does not gain, but on the contrary ſuffers a notable diminution of its weight; as if the increaſe of its activity was owing not to any thing ſuperadded by the Lime, but to ſome particular matter being ſeparated by it.

Some imagine that the Lime extricates a groſs earth from the Alcali, and in the room thereof ſubſtitutes its own more ſubtile and acrimonious matter. The earth, which precipitates upon mixing a purified ſolution of fixed alcaline Salt with Lime-water, is alleged in proof of this opinion: But that earth appears to be the Lime precipitated by the Alcali, and not a part of the Alcali precipitated by the Lime: Calcined by a ſtrong fire, it returns into Quick-lime.

Dr. Black, in the phyſical and literary eſſays publiſhed by a ſociety at Edinburgh, has advanced a new theory, which he has endeavoured to eſtabliſh by a number of experiments-----Fixed alcaline Salts, according to this gentleman, contain a large quantity of air fixed or impriſoned in them: The efferveſcence, which ariſes upon mixing them with acids, is no other than a tumultuary diſcharge of this air. Cauſtic alcalies, he finds, make no efferveſcence with acids, a proof that theſe alcalies have loſt their

Fixt Alcali.

pitated from blue Vitriol, the Copper in Verdegris, Tin, and Regulus of Antimony: This laſt they corrode into a calx, which by force of fire may be melted into an amber-coloured Glaſs. There are two ways of obtaining ſolutions of Iron in theſe Salts: One, by dropping a ſolution of the metal made in Aqua fortis into a ſtrong alcaline Ley, the acid will be abſorbed and neutralized by a part of the Alcali, and the Iron remains diſſolved by the reſt: The other is, by deflagrating Iron-filings with Nitre; the acid of the Nitre will be diſſipated in the deflagration, and great part of the Iron will diſſolve in water along with the remaining Alcali. (See page 73.) Theſe Salts, combined with Sulphur, diſſolve almoſt all the metals and ſemimetals, Gold itſelf not excepted. When made fluid by a ſtrong fire, they diſſolve Flint, Sand, and other earthy bodies, and on cooling concrete with them into a maſs, which proves diſſoluble in water or an indiſſoluble Glaſs, according as the proportion of the earth is large or ſmall. Added to phlegmatic ſpirits, either of the inflammable or volatile urinous kind, they imbibe the redundant phlegm, and thus render the ſpirit more concentrated. In pure vinous ſpirits they do not diſſolve, or only in very ſmall quantity, ſufficient however to give a ſenſible acrimony or alcaline impregnation to the ſpirit. If both the Spirit and the Salt are pure, the liquor receives no colour; but if any oily or reſinous matter be previouſly diſſolved in the ſpirit, or if the Salt be impregnated, though ſlightly, with inflammable matter of any kind, a conſiderably deep tincture will be produced. Fixt alcalies in general heighten the colour of vegetable and animal tinctures, whether drawn with water or with ſpirit; but they commonly vary the taſte, and often debaſe the ſmell of the preparation.

Combinations of them with acids.

They form with acids different neutral Salts according to the nature of the acid employed; with the vitriolic, a bitteriſh Salt, very difficult of ſolution in water, and not fuſible in the fire, commonly called vitriolated Tartar, the alcaline Salt made from Tartar being that which has chiefly been employed for theſe purpoſes; with the nitrous acid, they form a perfect Nitre; with the marine, a Salt greatly reſembling Sea-ſalt, but not perfectly the ſame, the alcaline baſis of Sea-ſalt being in ſome reſpects different from the common vegetable alcalies. They readily cryſtallize with any of the mineral acids, and with Tartar; with which laſt they compoſe a neutral Salt, much eaſier of ſolution than the Tartar itſelf, and hence called ſoluble Tartar. They do not eaſily cryſtallize with the acid of Vinegar or Lemon juice; theſe mixtures, if by careful management reduced to a cryſtalline form, ſoon deliquiate again in the air.

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their air; and from the loſs of this principle he deduces their cauſticity. Expoſed long to the atmoſphere, they become ſaturated with air afreſh, and are now found to be mild again and to effervesce like the plain alcalies. The caſe is the ſame in regard to Quick-lime: Chalk and other calcareous earths abound with air, and effervesce ſtrongly with acids: By whatever means this air is expelled, they become Quick-lime (which makes no effervescence) and by whatever means their natural quantity of air is reſtored, they return to their natural inactivity. Quick-lime abſorbs air from fixed alcaline Salts: Hence in the preſent proceſs, the Salt is acuated, and the Lime rendered inert. When Chalk, diſſolved in acids and thus diveſted of its air, is precipitated by Cauſtic alcalies which have no air to communicate, he finds the Precipitate to be a true Quick-lime; whereas, when the precipitation is made by plain alcalies, the Chalk, imbibing their air, returns to an indolent earth.

FIXT ALCALI.

Their affinities with acids.

There are different ways beſides immediate mixture, of obtaining combinations of fixt alcalies with acids, depending upon their great affinities with one another. Thus, (1.) When any metallic body is diſſolved in an acid, the addition of an alcaline Salt precipitates the metal: If the remaining liquor be filtered and evaporated, it leaves a neutral Salt compoſed ſolely of the acid and the Alcali. Some of the metals ſuffer a notable alteration in this proceſs: Thus the calx of Iron precipitated from the vitriolic acid in making vitriolated Tartar, is ſcarce at all revivable into malleable Iron again. (2.) When acids are combined with volatile alcalies into ammoniacal Salts, and this compound mixed with a fixt Alcali; on expoſing the mixture to the action of a moderate fire, in a retort or other convenient veſſel, the volatile Alcali ariſes, and the acid remains combined with the fixed: If it was not for the intervention of the fixt Alcali, it would ſublime in conjunction with the volatile. (3.) In like manner, when Sulphur, or Oils, or Reſins, are diſſolved by a fixt Alcali, the addition of any acid will ſeparate the ſubſtance before diſſolved, the acid and the Alcali uniting together; and even when both of them are previouſly ſaturated, the Alcali for inſtance with Sulphur, and the acid with metal, on mixing the two ſolutions together both the Sulphur and the metal fall, leaving only the Alcali and the acid combined in the liquor. (4.) When the Alcali is previouſly combined with one acid, the addition of a more powerful acid will break the union and diſengage the Alcali from the firſt acid. On the neutral Salt compoſed of fixed Alcali and Vinegar, pour ſome Spirit of common Salt: The acetous acid will inſtantly begin to exhale, and on applying a moderate heat will be totally diſſipated, leaving the Alcali combined with the marine acid. Add to this combination a due proportion of the nitrous acid, and the marine will be expelled, and a perfect Nitre remain. The vitriolic in like manner expels the nitrous, and takes poſſeſſion of the Alcali in its place: This being the moſt powerful acid, is not to be diſlodged by any other.

When this acid is combined with inflammable matter into Sulphur, it loſes its great affinity to alcalies. If the neutral Salt, compoſed of the vitriolic acid and fixed Alcali, be melted with powdered Charcoal, the reſult is a mixture of Alcali and Sulphur. On diſſolving this compound in water, the ſlighteſt even of the vegetable acids precipitates the Sulphur and unites with the Alcali.

Stahl, who firſt diſcovered the production of Sulphur by melting vitriolated Tartar with Charcoal, propoſed a problem to me, "to ſeparate the acid of "vitriolated Tartar, inſtantaneouſly, and in the palm of the hand." Being at Paris in 1715, I propoſed the ſame problem to the elder Geoffroy, and two years after appeared his Memoir, in which he endeavours to give a ſolution of it. He has not however hit the point, his proceſs being no other than that publiſhed by Stahl for making Sulphur, namely fuſion in a crucible and precipitation with acids. The true ſolution is this: Lay on the hand a coal not thoroughly ignited; ſtrew upon the burning part ſome vitriolated Tartar, blow it a little, and the acid will inſtantly ſeparate and leave the Alcali (*k*).

Fixt

(*k*) *Problem of ſeparating the acid of vitriolated Tartar.*] Another ſolution of this problem has been mentioned in page 173. In the author's ſolution given above, the ſeparation, though it cannot be ſaid to be performed immediately on the palm of the hand,

FIXT ALCALI. With inflammable substances.

Fixt alcalies combined with a little Oil, have their pungency proportionably covered (*k*): With a larger quantity, they form Sope. Impregnated by calcination with an empyreumatic animal Oil (*l*), they acquire singular qualities which have not hitherto been sufficiently examined: Thus, from a solution of green Vitriol and Alum, they precipitate the fine blue Fecula called Prussian-blue.

S O P E S.

SOPES.

THE fine hard white Sopes are made with Oil Olive, and an Alcali acuated with Quick-lime, which promotes the action of the Salt upon the Oil, and at the same time disposes the Sope to a hard and dry consistence, which it does not easily assume when made with plain Alcali. I have tried to prepare Sope with alcaline Ley alone, and with Lime-water alone: With the first, the Sope turned out softish and unctuous: With the latter, I obtained, not a true Sope, but a hard brittle compound, from which the Oil separated on trying to dissolve it in water. A quantity of common Salt is generally added in the process, but it does not enter the composition of the Sope: The use of this Salt is, when the Oil has been incorporated, by boiling, with the alcaline Salt of the Ley, to promote the separation of the saponaceous concrete from the water: It is only at this period that the Sea-salt is added. The Sea-salt may be recovered from the remaining liquor by crystallization; if any part of it happens from unskilful management, to be retained in the Sope, it separates in little crystals as the Sope dries.

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hand, is the most perfect and apparent, only the acid being dissipated, and the Alcali left by itself pure.

(*k*) *Pungency covered by Oil.*] Hence some have endeavoured to improve the preparation of fixed alcaline Salts for medicinal use. Instead of burning out all the Oil of the vegetable by thorough calcination of the ashes in an open fire, so as to obtain a pure Alcali; they endeavour to retain in the Salt as much as possible of the Oil, by slowly incinerating the subject with a close smothering heat. These oily alcalies, or *medicated* Salts, as they are called, are of a brown colour, and in taste much less acrimonious than the purer white alcalies.

(*l*) *Fixt alcalies impregnated with animal Oil.*] This impregnation is effected by mixing pure fixt alcaline Salt with twice its weight of ox-blood evaporated to dryness and reduced into powder; and calcining the mixture in a crucible, till it ceases to flame. The Salt is then pulverized and thrown, whilst hot, into twice its quantity or less of water, and the Lixivium passed through a filter.

The properties of this Lixivium, hitherto observed are these. Mixed with a solution of Alum and Vitriol of Iron, it precipitates green and blue Feculæ: See page 72. Added to a solution of Gold made in Aqua regis, or of Silver, Quicksilver, or Zinc in Aqua fortis, in such proportion as to saturate the acid, it precipitates the metals like simple alcalies: But if a larger quantity of the Ley is afterwards added, all the Precipitates are redissolved by it. Mr Margraff relates (*Memoires de l'Acad. de Berlin*, 1745) that even when the Precipitates have been carefully edulcorated, or washed from their saline matter by hot water, they still readily dissolve in the Lixivium; and this, whether the precipitation has been made with the Lixivium itself, or with common alcalies. Lead and Tin resist this menstruum: After they have been thrown down by it from their solutions in acids, they are not taken up again by a larger addition.

Caustic alcalies, applied in the same manner, are not found to dissolve any of the above metals.

The greateſt quantities of Sope are made in Spain, Portugal, France and Italy; Oil Olive being in thoſe countries moſt plentiful. The moſt common and the cheapeſt, of the foreign Sopes, is that of Venice. I have ſeen the preparation of this ſort: It is made from three parts of good Oil Olive, and two of a cauſtic Ley; which Ley is drawn from two parts of Spaniſh Soda and one of Quick-lime, with a ſuitable quantity of water. No metalline veſſels are made uſe of: The boilers are compoſed of building ſtone, joined by a particular cement, and ſecured with iron cramps: In theſe the Oil and Ley, to the quantity of ſome hundred weights at a time, are kept gently ſimmering for ſeveral days and nights. The Venetians prepare alſo a green Sope, from old Oil, the Mother-ley of the white Sope, and other refuſe matters, adding a certain portion of the juice of Beet-leaves, which communicates the green colour: The juice is preſſed out by a horſe-mill conſiſting of an horizontal ſtone, with a perpendicular one turning upon it, as in the Gunpowder-mills——The common coarſe Sopes are made with Tallow; and the ſoft, blackiſh and greeniſh ſorts with Train-oil. SOPES.

Fixed alcalies unite much more difficultly with eſſential Oils than with the expreſſed. For making a Sope with Oil of Turpentine, formerly celebrated as a medicine under the names of Sope of Tartar, the Univerſal Corrector, *&c.* Different proceſſes have been purſued, and all of them tedious or defective. Some mix the Oil of Turpentine with a well calcined Salt of Tartar, and ſtir them together every day for half a year or longer, till the union is completed: Some dry the mixture occaſionally, as often as it is found to have imbibed moiſture from the air. Some have ſecured the mixture in a ſtrong glaſs fixed to the clapper of a mill or the ſail of a windmill, that by this means it might be kept in conſtant agitation; but ſimple agitation is not ſufficient. Some boil the Oil with a cauſtic Ley, keeping the whole continually ſtirring, nearly in the ſame manner as for making Sope with expreſſed Oils. Others pulverize the Salt, ſtrongly heated, in a mortar, and pour upon it whilſt very hot; the Oil of Turpentine likewiſe heated: By this method a Sope is moſt expeditiouſly obtained, but the more ſubtile parts of the Oil are diſſipated. The beſt way is, to mix the Oil and Salt together moderately hot, and digeſt them in a low glaſs body for a day, then grind and digeſt them again (*m*). It is not of much importance to be curious about the proportions: If the Salt predominates, the Oil will the more readily and more perfectly unite with it, and when the union is obtained, the ſuperfluous Salt may be ſeparated by deliquiation: The proceſs Sope with eſſential Oils.

(*m*) *Combination of fixed alcalies with eſſential Oils.*] Stahl has diſcovered an eaſy method of obtaining this union, by the mediation of Spirit of Wine--If ſome fixt alcaline Salt be put into a vial, a phlegmatic Spirit of Wine poured upon it, and above this a light diſtilled Oil; the ſeveral matters, ſhaken together, ſeparate again, and form four diſtinct ſubſtances, which ſome of the fanciful ſons of chemiſtry have reſembled to the four elements ſeparating from the chaos; the Alcali at the bottom repreſents earth; the phlegm of the ſpirit, imbibed by a part of the Alcali, repreſents water; the ſpirit itſelf ſtands for air; and the diſtilled Oil for fire. Theſe phænomena having been two or three times exhibited, and the mixture, two days after, being ſhaken a third time, no ſeparation enſued, the Alcali and Oil uniting into a thick ſaponaceous maſs, the product here required. To ſucceed in this experiment, the quantity of Oil ſhould be ſmall.

SOPES. ceſs may be finiſhed by drawing over ſeveral times from the Sope ſome rectified Spirit of Wine, by which, if there is any redundant Oil, it will be in good meaſure ſeparated. The other eſſential Oils are ſtill more difficultly combinable with alcalies than that of Turpentine; but empyreumatic Oils unite more eaſily. Volatile alcalies do not form a Sope with any kind of Oil: They only thicken expreſſed Oils into the conſiſtence of a liniment; and it is only the Spirit of Sal ammoniac made with Quick-lime that does this.

Common hard Sope diſſolves in water (though not perfectly) by virtue of its alcaline Salt. But it diſſolves alſo, and that in a more perfect manner, in rectified Spirit of Wine, though this menſtruum has no action either on the Oil or the Salt by themſelves: It is obſervable, that a ſmall proportion of Sope gives a quite thick conſiſtence to a very conſiderable quantity of the ſpirit. On adding any acid to a ſolution of Sope, its ingredients ſeparate from one another, the Alcali being abſorbed by the acid, and letting go the Oil (*n*).—— Sope is uſed medicinally as a detergent and deobſtruent: It diſſolves tenacious mucus, and promotes the natural excretions. If there are any medicines capable of diſſolving the calculus in the bladder, Sope is one of the principal (*o*).

PART

(*n*) *Solubility of Sope.*] This concrete diſſolves ſtill more perfectly, and in larger quantity, in pure proof-ſpirit. Sixteen ounces of rectified ſpirit ſcarcely diſſolve one ounce of Sope; but the ſame quantity of a mixture of equal parts of rectified ſpirit and water, diſſolves with eaſe above five ounces into a colourleſs tranſparent liquor. This ſolution is commonly called liquid Sope--- It is obſervable that the Oil, ſeparated from ſolutions of Sope by means of acids, diſſolves, like eſſential Oils, in Spirit of Wine. See page 464.

(*o*) *Additional Article.*

VEGETABLE EARTH.

THE earthy parts of vegetables are not to be ſeparated, in a tolerably pure ſtate, but by diſſipating or deſtroying the other principles. There are two general means of effecting this; putrefying, and burning the ſubject.

The earths procured by theſe two proceſſes, from one and the ſame plant, are in all their obvious properties remarkably different from one another; but in thoſe obtained by one proceſs from different plants, no diverſity has been obſerved. All vegetables ſeem to be reſolved by putrefaction into one ſimilar earth, and by fire into another.

The earth produced from vegetables by putrefaction, of which common black mould is principally compoſed, approaches ſomewhat to the nature of the leſs tenacious kinds of clayie Earths or boles: Like them, it readily imbibes water, extends a little when moiſtened, proves in ſome ſmall degree ductile, and is not acted upon (in the cold or in a moderate warmth) by acid liquors: It differs from them in being leſs coherent, and acquiring no additional hardneſs in the fire. Calcined by a very ſtrong fire it does not become ſimilar, either in appearance or in its chemical properties, to the earth procured by burning the plant at firſt---Some have ſearched in mould for the immediate pabulum or nutrimental matter of vegetables, but the enquiry has hitherto been fruitleſs: The richneſs of mould as a ſoil for plants, does not ſeem to depend on its having any particular ſaline or other impregnation, but on its property of imbibing and retaining humidity more effectually than any other earth.

The earth prepared by fire, or the aſhes of vegetables freed from their ſaline parts, diſſolves readily and plentifully in all acids, and appears to be ſimilar to the mineral earth called Magneſia, or the earthy baſis of the bitter purging Salts of mineral waters: (See page 190.) It forms the ſame compounds with acids; and like that earth alſo, it acquires no acrimony nor any change of its quality, from fire. By the proceſs of putrefaction,

faction, in mixture with putrefcible fubftances, it fuffers no change, the incinerated earth being recoverable from that which the putrefaction produced, by means of acids; and afterwards from the acids, by precipitation with alcaline Salts and by calcination; and proving ftill, on all the trials that have been made, the fame earth as at firft.

The vitrification of the mineral Magnefia has not been tried. The vegetable incinerated earth, mixed with a very moderate proportion of fixed alcaline Salt, vitrifies with eafe, and forms a greenifh hard Glafs. The common green Glafs-bottles are made chiefly of vegetable afhes, that have not been freed from the Salt produced in the burning; the proportion of which is often fufficient for the fufion, not only of the earthy part of the afhes themfelves, but likewife of an additional quantity of Sand or other mineral Earths. The warm imagination of fome of the chemifts has wantoned in airy fpeculations about this green Glafs, impreffed with the indelible character of the verdant kingdom, tinged with an unfubduable green anima of plants.

In fome chemical operations, where retorts or other veffels of green Glafs are expofed for a confiderable time to the action of a ftrong fire in a Sand-bath, the bottom of the Glafs that had been in contact with the Sand, is often found tinged in part with an opake whitifhnefs. From this obfervation I was induced to cement pieces of Glafs in a crucible, with Sand and many other powdery matters: In thefe experiments, the Glafs frequently fuffered a remarkable change in its whole fubftance, being converted throughout into a body more refembling a fine kind of earthen-ware than Glafs. Mr. Reaumur was led to the fame difcovery by analogical reafoning: From the effects of Bone-afh, Charcoal, Soot, &c. in foftening caft Iron, and turning forged Iron into Steel, (See page 78.) he fufpected, that the fame fubftances might produce alfo fome notable alterations in Glafs; and accordingly firft made trial of thofe powders, and afterwards of others---The following is the general refult of the experiments made upon this fubject by him *. An account of our own will follow this to the prefs, in a work which I have long promifed to the publick.

VEGETABLE EARTH.

Green Glafs, furrounded with white earthy matters, as white Sand, Gypfum or Plafter-of-Paris, &c. and expofed to a confiderable heat not ftrong enough to alter its figure, as that of a potter's furnace, acquires different fhades of blue, and by degrees begins to grow white. On breaking the Glafs, the white coat appears to be compofed of fine, gloffy, fattin-like fibres, running tranfverfely and parallel to one another; the Glafs in the middle being fcarcely altered. On continuing the cementation, the change proceeds further and further, till at length the white fibrous parts from both fides meet in the middle, and no appearance of Glafs remains. By this procefs entire veffels of Glafs are converted into veffels of Porcelane.

The fubftance, into which the Glafs is thus converted, is opake, compact, internally of great whitenefs, equal to that of the fineft China-ware, but externally of a much duller hue. It is confiderably harder than Glafs, much lefs fufible in the fire, and fuftains alternations of heat and cold without injury. Veffels of it, cold, bear boiling liquors, and may be placed on the fire at once, without danger of their cracking. I have put a veffel of this Porcelane, fays the author, into a forge, furrounded it with coals, and kept blowing vehemently for near a quarter of an hour: I have melted Glafs in this veffel, without its having fuffered any injury in its figure.

If means could be found of giving the outfide a whitenefs equal to that of the internal part, Glafs veffels, might thus be converted into a valuable kind of Porcelane fuperior to all that have hitherto been made. Chemiftry may receive from this difcovery in its prefent ftate, fuch veffels as have long been wanted; veffels, which with the compactnefs and impenetrability of Glafs, are free from its inconveniencies.

This difcovery has not as yet been brought to the degree of perfection which the author thinks it capable of being brought to. Many other experiments remain to be made, with different kinds of Glafs, as well as with different cementing materials.

* In the Memoirs of the Royal Academy of Sciences for the year 1739.

The

VEGETABLE EARTH.

The common green glaſs bottles yielded a Porcelane of tolerable beauty; window glaſs and drinking glaſſes a much inferior one; whilſt the finer cryſtalline glaſſes could not be changed into Porcelane at all. Whence it is natural to preſume, that there may be ſome ſorts of Glaſs more proper than any that have yet been tried. It may perhaps be found neceſſary to prepare a coarſe kind of Glaſs on purpoſe.

With regard to the cementing materials, he finds white Sand and Gypſum, or rather a mixture of both, to anſwer the beſt of any that have been tried. Coloured earths generally make the external ſurface of a lighter or deeper brown colour; Soot and Charcoal, of a deep black; the internal part being always white. Theſe external colours may be ſo managed as to prove in ſome caſes an embelliſhment. The glazing and vitreous colours, commonly applied upon other Porcelanes, he finds may be equally applied upon this.

Mr. Reaumur ſuppoſes (agreeably to the theory by which he was led to the diſcovery), that the converſion of Glaſs into Porcelane is owing to the ſulphureous or unvitreſcible particles of the matters with which it is cemented, being forced into it by the heat.

PART III.

CHEMICAL HISTORY

OF THE

ANIMAL KINGDOM.

SECTION I.

Of ANIMAL SUBSTANCES *in general, and their* NATIVE PRINCIPLES.

ANIMALS are nouriſhed, mediately or immediately, by vegetables. The alimentary ſubſtance, of whatever kind, is changed in the body, by a power of which we know only the effect, into two kinds of matter; (1.) An excrementitious one, which paſſes off through the inteſtines; and (2.) A fluid which is the direct pabulum of the animal; which is tranſmitted, though not without new changes, through all the veſſels; from which are ſecreted and elaborated, by different organs, all the animal juices deſtined to different purpoſes in the œconomy, and all the excrementitious fluids; from which the ſolid parts alſo receive their nutriment and increaſe. ANIMALS.

How widely do theſe ſubſtances differ from one another, as well as from every thing that pre-exiſted in the alimentary ſubject! We have no where more ſtriking examples of the converſion of matter into new forms, than in the bodies of animals; changes effected by a natural proceſs, which art has attempted in vain to imitate or account for.

ANIMALS. Different alimentary ſubſtances are not by this proceſs equally changeable: They differ obviouſly in regard to the facility of their being digeſted or aſſimilated in the body: Perhaps alſo there are differences in the quality of the animal juices elaborated from different aliments. The common experience of the tables ſhews differences in animal fleſh, which may in great part be aſcribed to the food.

There are many ſubjects, of the vegetable as well as mineral kingdom, (excluſive of the directly noxious ones), whoſe active principles appear to be unſubduable by the digeſtive organs of animals, and which tranſmit their own ſpecific qualities to the blood, and to fluids ſecreted from it. Thus Rhubarb communicates its purgative virtue to the milk of the breaſt, and its deep yellow colour to the urine (*a*).

ANIMAL SUBSTANCES. ANIMAL SUBSTANCES, chemically examined, are found to contain, beſides the general principles Water and Earth,

1. A gelatinous matter, more or leſs tenacious, ſoluble in Water, indiſſoluble in rectified Spirit of Wine. This principle appears to be of two kinds; one which diſſolves in boiling water more readily than in cold; and another, which though eaſily ſoluble in the cold, is by boiling water coagulated and rendered indiſſoluble. The gelatinous matter of the ſolid parts is of the firſt kind; that of ſome (perhaps of all) of the fluids, of the laſt.

2. A ſubſtance diſſoluble in Spirit of Wine, and which remains behind upon evaporating the ſpirit, containing oftentimes the taſte, particular flavour, medicinal activity, or colour, of ſuch ſubjects as are eminently poſſeſſed of thoſe qualities, as Cantharides, Caſtor, Cochineal, *&c.*

3. An unctuous or fat matter, of different degrees of conſiſtency, eaſily liquefiable by heat, not diſſoluble in water or in ſpirit, but for the moſt part miſcible with cauſtic alcaline Lixivia into Sope.

4. A volatile principle, which exhales in the heat of boiling water, and which may ſometimes be collected by diſtillation in the form of an eſſential Oil (*b*).

5. An acid; which ſeems to be more frequent in the animal kingdom than the chemiſts have commonly imagined; for beſides the manifeſt acid of certain inſects, experiment has diſcovered that there is a latent acid principle in moſt kinds of animal ſubſtances.

THESE

(*a*) *Qualities of vegetables unſubdued in animal bodies.*] Many other examples of this kind might be mentioned; among which perhaps there is none more remarkable than the experiments formerly related (p. 387.) of the bones of animals being ſtained of a deep red by a red drug (Madder) taken with the food.

(*b*) *Eſſential Oil.*] Our author appears to be the firſt who diſcovered any truly eſſential Oil in the animal kingdom; ſee the examination of ants in the following ſection. It is ſaid that ſome of the ſtrong-ſcented animal ſubſtances alſo, as Caſtor, yield on being diſtilled with water, when large quantities are ſubmitted to the operation at once, a ſmall portion of actual Oil containing the whole ſmell of the ſubject. From hence ſome have preſumed, that animal odours in general reſide, like thoſe of vegetables, in a principle of this kind, though the proportion of Oil, in animal as well as in many odoriferous vegetable ſubſtances, is too ſmall to be collected on diſtilling moderate quantities of the ſubject.

ANIMAL SUBSTANCES.

THESE may be looked upon as the native principles of animal matters; all the conſiſtent parts of animals being reſoluble into more or fewer of theſe, without deſtroying the original qualities of the ſubject; which qualities are uſually preſerved in one or other of the parts ſeparated. There are however ſome particular animal juices, whoſe principles cannot eaſily be referred to any of theſe.

The foregoing principles are in ſome degree analogous to the Gums or Mucilages, the Reſins, the expreſſible and eſſential Oils, and the eſſential Salts, of the vegetable kingdom. But notwithſtanding the agreement of the reſpective principles of the two kingdoms in ſome of their general properties, their internal conſtitution appears to be eſſentially diſtinct. How different is an animal gelly, thrown in the fire, from a vegetable Gum, in its inflammability and in its ſtench!

The ſoft and fluid parts of animals (*c*) are in general much more diſpoſed to putrefy than thoſe of vegetables; and when putrefied, prove more acrimonious and more offenſive: Compare a rotten apple with cadaverous fleſh, and how different will putrefaction appear to be in the two kingdoms! Vegetables by putrefaction approach in ſome meaſure to the nature of animal ſubſtances in their perfect ſtate; not indeed in regard to their native principles, but in regard to thoſe into which they are ultimately reſoluble by the deſtructive action of a ſtrong fire.

A degree of putrefaction oftentimes takes place in the bodies even of living animals: Thus, after long abſtinence from food and liquors, the juices are found to be thin, ſaline, acrimonious, and fetid. From ſuch a ſtate of the juices, brought on by various cauſes, ariſe many diſorders of the animal machine, which have in vain been attempted to be counteracted or explained upon mechanical principles (*d*).

Many

(*c*) *Soft parts diſpoſed to putrefy.*] The ſolid parts alſo, and even thoſe which have very little of the animal principles beſides the earth, are found, when reduced into ſmall parts and kept moiſt, to be greatly diſpoſed to run into putrefaction. I have ſeen the common abſorbent powders, as Crabs-eyes and Crabs-claws, when levigated with water and ſet by moiſt, in large quantities together and in hot weather, become in ſome degree putrid in a few hours.

(*d*) *Animal putrefaction.*] The doctrine of putrefaction, both in living and in dead animals, has lately received great light from the curious experiments and obſervations of Dr. Pringle, many of which are intereſting to the chemiſt as well as the phyſician. See the appendix to his *Obſervations on the Diſeaſes of the Army.*

He obſerves, that during putrefaction, a quantity of air is generated, all the humours become gradually thinner, and the fibrous parts more lax and tender; that the craſſamentum of human blood changes by putrefaction to a dark livid-coloured liquor, which tinges a large quantity of ſerum of a tawny hue like Ichor, *&c.* and recent urine of a flame colour, like that in fevers and the ſcurvy; that this laſt mixture, on ſtanding an hour or two, gathers a cloud like that of the crude water of acute diſtempers, with ſome oily matter on the ſurface like the ſcum on ſcorbutic urine; that the ſerum of blood depoſites, in putrefaction, a ſediment reſembling well digeſted pus, and changes to a faint olive-green; and that the green colour of ſalted meats is owing to this cauſe, and not, as is commonly ſuppoſed, to the brine.

ANIMAL SUBSTANCES.

Many animal juices are diſpoſed likewiſe to coagulate and grow thick, and to change in part into hard concretions, without any manifeſt evaporation of the fluid. By this property they are fitted for augmenting, and repairing the waſtes of the ſolids. Thus the ſhells of ſundry fiſhes receive annually a new incruſtation; and thoſe of others are annually thrown off and ſupplied by new ones produced from the juices of the animal.

It has been ſuppoſed, that the teſtaceous, calculous, and other ſolid animal concretions, are only a bare ſeparation and coaleſcence of the earthy particles previouſly diſſolved or held ſuſpended by the fluids; but a chemical examination ſhews that they are more. Evaporate the watery part of any animal juice, and by a ſuitable fire burn off the combuſtible principles, that only the earth may remain: Procure alſo, by the like means, the pure earth of any of the hard parts of animals; and the two earths will be found eſſentially different from one another (*e*).

He finds that putrefaction is prevented or retarded by all ſaline ſubſtances, even by fixed and volatile alcaline Salts, which have been commonly ſuppoſed to produce a contrary effect, by vinous ſpirits, aromatics, many gummy-reſins, the bitter, aſtringent, acrid herbs, &c. . . That Sea-ſalt, the common ſeaſoning of our proviſions, is one of the weakeſt in antiſeptic power; that vitriolated Tartar for inſtance is twice as ſtrong; Sal ammoniac thrice, Nitre upwards of four times, fixed and volatile alcalies as much, Borax above twelve times, Salt of Amber above twenty times, Alum above thirty times, and the ſoluble part of Camomile-flowers not leſs than one hundred and twenty times, as ſtrongly antiſeptic as common Salt . . . That animal ſubſtances already corrupted are capable of being recovered and made ſweet again: A ſmall piece of putrid fleſh, ſteeped two or three days in an infuſion of Camomile renewed every day, loſt its offenſiveneſs; and being then put into a freſh infuſion, was kept a twelvemonth in the ſame liquor, and ſtill remained firm and uncorrupted . . That Sea-ſalt in ſmall quantity, as ten grains to two drams of fleſh and two ounces of water, inſtead of reſiſting, both haſtens and heightens the putrefaction . . And that ſome of the ſoluble earths alſo, as Chalk, promote putrefaction; whilſt others, as eggſhells, ſeemed to retard it.

It is remarkable, that notwithſtanding the ſtrong tendency of animal matters to putrefaction, yet broths made from them with the admixture of vegetables, inſtead of putrefying, turn ſour. Dr. Pringle finds that animal fleſh in ſubſtance being beat up with bread or other farinaceous vegetables, and a proper quantity of water into the conſiſtence of a pap, this mixture likewiſe, kept in a heat equal to that of the human body, grows in a little time ſour, whilſt the vegetable matters without the fleſh ſuffered no ſuch change. He obſerved that in a ſmaller degree of heat, the change was more ſlow, and that the matter before it became acid yielded a vinous ſmell like that of fermenting liquors.

(*e*) *Earths from the ſoft and hard parts different.*] The principal difference I have obſerved is this; that the earths of the ſoft parts of animals, at leaſt of thoſe which were examined, diſſolved with eaſe in the vitriolic acid, whilſt thoſe of the hard parts did not diſſolve at all, any more than the mineral calcareous earths. See the article of animal earths at the end of next ſection.

SECT.

SECT. II.

Products from Animal Substances by Fire.

ANIMAL Substances (a few excepted) on being distilled in close vessels by a strong fire, give over, not a manifest acid liquor as vegetables do, but an urinous or volatile alcaline one, and commonly more or less of a concrete volatile alcaline Salt; together with an empyreumatic Oil, more fetid than the Oils of vegetables, and of a different kind of fetor. On calcining the remaining coal in open vessels, and elixating the ashes with water, we sometimes obtain a portion of a kind of fixed saline matter, but very rarely a perfect alcali like that extracted from the ashes of vegetables (*f*). ANIMAL SUBSTANCES.

Before we proceed to examine Animals and their parts in particular, it will be proper to give an account of the preparation and properties of the general products obtained by this operation.

I. *Volatile Animal Salts and Spirits.*

WE have formerly seen that the alcaline Salt procurable from vegetables is wholly a child of art. The volatile alcalies obtained from animals are in like manner artificial productions, never found to exist naturally in any animal substance in its perfect state: They are generated by the action of fire, and by putrefaction; and not by any known power besides. VOLATILE SALTS.

So soon as an animal substance begins to putrefy, it begins to discover an alcaline quality; and this volatile substance, now produced in it, may be separated by distillation in a very gentle warmth (*g*). Hence in the bodies of animals

(*f*) *Salt from the ashes.*] The ashes of truly animal substances, are never observed to yield any perfect alcaline Salt like that produced from vegetables. Wherever we obtain a fixed Alcali of this kind, the subject is judged, in so far as it affords that Salt, to be of a vegetable nature or to participate of a vegetable impregnation.

The small portion of saline matter, extracted from the ashes of some animal substances, appears to be chiefly of the marine kind. Our author himself finds, in examining bones and horns, that a Salt of this kind is obtainable from them in their crude state, by boiling them with water. If the acid of this Salt should be dissipated in the burning, so as to leave the Alcali behind; this Alcali may be easily distinguished from those of the vegetable kingdom by its forming with the vitriolic acid a bitter neutral Salt, easily soluble in water and fusible in the fire, called *Sal mirabile*, (See page 193.) whilst the vegetable Alcali forms with the same acid a Salt less bitter, very difficult of solution, and not at all fusible, called vitriolated Tartar. (See page 190).

(*g*) *Putrid substances alcaline---yield their Alcali in gentle warmth.*] This is the general doctrine of the chemists, but it does not appear to be strictly just. They seem to have been misled by applying to all animal substances what they had found to obtain in one, but what a further examination shews to

VOLATILE SALTS.

mals themſelves, the juices are ſometimes found to be alcaleſcent; more or leſs ſo, in proportion to the degree to which the putrefaction has ariſen.

From thoſe ſubſtances on the other hand, which have not ſuffered putrefaction, no Alcali is obtainable without a ſtrong heat; the formation of the Alcali, when effected by fire alone, not taking place till the ſubject is in a ſtate of ignition. The Alcali itſelf, when once produced, whether by fire or by putrefaction, is always of the ſame volatility.

Diſtillation.

IN order to the preparation of volatile Salts, the ſolid parts of animals, which are little diſpoſed to putrefy, as Horns, Bones, Hoofs, Hair, *&c.* are diſtilled in earthen or coated glaſs retorts placed in a reverberatory or other furnace, capable of giving a conſiderably ſtrong heat: In the large way of buſineſs, an iron pot is uſed for the diſtilling veſſel. The fire being increaſed by degrees, there ariſes firſt a phlegmatic liquor, in greater or leſs quantity according as the ſubject was leſs or more dry: In the progreſs of the operation, the liquor that diſtils proves more and more alcaline and urinous, and is now called Spirit: Soon after, a concrete Salt appears in the recipient, together with a yellow Oil; which is ſucceeded, on increaſing the fire to the utmoſt, by a dark coloured thick Oil.

Liquid ſubſtances, as Urine and Blood, are previouſly putrified, and then diſtilled in a ſand-bath. In regard to the putrefaction, the ſubject ſhould be completely putrid, but the proceſs muſt not be carried too great a length; for if it is, the volatile Salt will be diſſipated in the air, and nothing will ariſe in the diſtillation but a little fetid Oil. The diſtilling veſſel ſhould not be above one half filled, theſe kinds of liquids being extremely apt to froth up and run over: Nor ſhould the junctures be very cloſely luted, leſt the expanſive vapours which ariſe from theſe ſubjects ſuddenly and in great abundance, burſt the veſſels or blow off the head or receiver. This laſt caution is equally neceſſary to be obſerved in the foregoing diſtillation of ſolid ſubſtances by a reverberatory or naked fire.

The liquor which in theſe proceſſes is called Spirit, is no other than a portion of the volatile Salt diſſolved in the water or phlegm, and tainted with the fetid Oil. The Salt itſelf alſo, which concretes in a ſolid form about the ſides and in the upper part of the recipient, is ſtrongly impregnated with the ſame fetid ſmell, and with the unſightly yellow or browniſh colour of the Oil.

Rectification.

IN order to ſeparate and purify the ſeveral products, the Salt may be waſhed down by ſhaking about the liquid matters in the receiver, and the whole poured into a wide-mouthed glaſs: On ſtanding, the Salt falls to the bottom, the Spirit ſwimming above it, and the Oil on the top. The liquor may then be

to obtain in very few, if any, beſides, at leaſt in any conſiderable degree.

Putrefied urine gives plain marks that it contains a volatile Alcali already generated: But putrid blood and fleſh are not ſenſibly alcaline, and yield no Alcali in diſtillation till after the phlegm has ariſen.

We have formerly ſeen that volatile alcalies are powerfully antiſeptic. Perhaps, as Dr. Pringle obſerves, it is owing to this Alcali in putrefied urine, that its ſteams are ſo little prejudicial to health; whilſt thoſe of other putrid animal matters, which want that corrector of putrefaction, are often productive of dangerous diſeaſes.

be poured off from the Salt, and the Oil and Spirit parted from one another by a funnel or otherwise (*h*). VOLATILE SALTS.

After this gross separation, the spirit is to be distilled over again, in a glass retort, with a very gentle heat; and the fire discontinued, or the receiver changed, as soon as its fetid Oil is perceived to arise. By repetitions of this process, it loses its offensive smell, though it cannot be totally divested of its Oil.

The Salt is rectified or purified by repeated sublimations; with the addition of animal or vegetable ashes, fine white Clay, or other like earthy powders, which absorb and keep down a portion of the Oil. Great part of the Oil may be separated also by digestion with highly rectified Spirit of Wine; this menstruum dissolving and extracting the Oil, without being able to dissolve any considerable quantity of the Salt: The little of the Salt which it does take up, may be separated by distillation in a tall glass with a gentle heat; the Salt arises first, and afterwards the Spirit, greatest part of the Oil remaining behind.

The Salt contained in the volatile Spirit may in like manner be recovered in its solid form by gentle distillation. For this purpose, the process is to be stopt as soon as the Salt has arisen, before any phlegm comes over to dissolve it; whereas, in rectifying it for Spirit, the distillation is continued till phlegm enough has arisen to dissolve the whole of the Salt (*i*).

Volatile Salts can scarcely by the above methods of rectification be rendered perfectly pure. Though when newly rectified, they appear sufficiently white, and discover only their own pungent odour, yet in long keeping they contract a brown colour and an ill smell, and thus betray how imperfectly they had been freed from the Oil.

The most effectual method of purifying them, though too expensive an one for common purposes, is, to combine them with mineral acid spirits, that of Sea-salt for instance——When volatile alcalies are saturated with the acid, they form a neutral Salt of a middle degree of volatility; if the filtered liquor be set to evaporate, the water totally exhales long before the Salt begins to arise. Some of the chemists, anxious when they had Salts that were fixed, to make them volatile, and when they had volatile ones to make them fixed, imagined they

(*h*) *Spirit and Oil parted.*] The Spirit may be commodiously separated from the Oil by filtration through wet paper, which will retain all the Oil that is not intimately combined or dissolved in it.

(*i*) *Phlegm enough to dissolve the Salt.*] The distillation should be stopt as soon as ever the Salt appears to be all dissolved; for the phlegm drawn off after this period can serve only to weaken and dilute the Spirit in proportion to its quantity. The author of the *Pharmacopœia reformata* advises the operation to be discontinued a little before the total dissolution of the Salt, and it were to be wished that this method was received in practice. The strength of volatile spirits, at present very vague and uncertain and not easily to be judged of, would then be always nearly of one standard; for if a little of the Salt remains undissolved at the bottom of the liquor, we may be sure that the spirit is saturated, or impregnated with as much as it can take up. This method would likewise prevent the frauds that have been practised in regard to these kinds of preparations; for a little solid Salt remaining at the bottom (provided this Salt be found to be a volatile alcaline one, which is very easily determined) would be a certain mark that the spirit is not only strong, but free from the sophistications mentioned in page 490.

VOLATILE SALTS. they had here a curious fixation of the volatile Alcali, and expected from it uncommon effects, not conſidering, that the compound is by no means an alcaline, but a neutral Salt, and no other than plain Sal ammoniac; for common Sal ammoniac is an artificial neutral Salt, compoſed of volatile Alcali and marine acid. (See pag. 216, *ſeqq.*) If this compound be mixed with fixed Alcali or with Chalk, and ſet to ſublime in a retort or other proper veſſel, the acid will be abſorbed by the fixed Salt or the Earth, and the volatile Salt will ariſe pure.

Their identity and diſſimilarity. THE volatile Salts and Spirits, obtained from different animal ſubſtances, have been ſuppoſed to poſſeſs ſpecific medicinal virtues, correſponding to thoſe of the ſubject they were produced from. But fire and putrefaction, the agents by which theſe products are procured, deſtroy the ſpecific qualities of all animals and vegetables; and the volatile matters, that ariſe in the diſtillation, have no more reſemblance to the original ſubject than the coal that remains behind. The Salt and Spirit of Cantharides have no greater acrimony than thoſe of Hartſhorn-gelly: Thoſe of the moſt poiſonous and loathſome animals, the Tarantula, the Scorpion, the Aſp, the Spider, and the Toad, are neither leſs innocent nor more offenſive, than thoſe of the Partridge, the Lark, and the Ortolan.

Though theſe preparations, however, poſſeſs nothing of the properties of the ſubject which afforded them, it does not follow, that in their ordinary ſtate they are all perfectly the ſame, as ſome have too haſtily concluded. When brought to their ultimate degree of purity, their identity is not to be denied: But ſo long as they participate of Oil, which they always do as prepared in the common manner for medicinal or other uſes, thoſe Oils may vary their quality; for though pure animal Salts appear all to be one and the ſame, yet animal Oils are not ſo. The Salts of different animal ſubſtances exhibit, by virtue of their diſſimilar Oils, very different phænomena in the precipitation of certain metallic ſolutions, as thoſe of venereal Vitriol and corroſive Sublimate.

The pure volatile Salt or Spirit of Sal ammoniac may be rendered perfectly ſimilar to thoſe of any particular animal matter, by adding a ſmall portion of the Oil of the ſubject whoſe Salt or Spirit is to be imitated, and combining them together by digeſtion, ſublimation, or diſtillation.

Their general properties. WITH regard to the properties of volatile Salts, they poſſeſs the general characters of alcaleſcence in common with the fixed alcalies, as changing Syrup of Violets green, effervеſcing with acids, and precipitating ſubſtances diſſolved in them (*k*).

They

(*k*) *Volatile alcalies precipitate ſubſtances diſſolved in acids like the fixed.*] This rule is much leſs general, and the effects of volatile and fixed alcalies are in theſe reſpects, at leaſt in regard to metallic ſolutions, more different from one another, than has been commonly ſuppoſed.

Thus though Gold, diſſolved in Aqua regis, is precipitated by volatile alcalies, when only a certain quantity of the Alcali has been added, equally as by the fixed; yet on adding a larger quantity of the volatile Alcali, great part of the precipitated Gold is taken up again, whilſt the fixed, in whatever quantity it is employed, rediſſolves none: The Precipitate made by volatile alcalies fulminates with violence on being expoſed to a ſmall degree of heat, whilſt that

They form with the acid a neutral Salt, which readily concretes upon duly evaporating the liquor, into a cryſtalline form, and which requires a conſiderable heat to make it ſublime, whilſt the volatile alcalies by themſelves exhale even on the warm hand. Theſe neutral compounds are called by the general name of *Ammoniacal Salts*; common Sal ammoniac being the principal of them, or that which has been the moſt generally known. Of the ammoniacal Salts compoſed of volatile alcalies and the different mineral acids, an account has already been given in the firſt part of this work, pag. 194. 197, 216. VOLATILE SALTS.

Volatile alcalies have leſs affinity or attraction to acids than fixed alcalies have; fixed alcalies abſorbing the acid from them, on which the volatile Alcali, now ſet at liberty, ariſes with a gentle warmth; and on this principle depends the common method of extracting the volatile Alcali from ammoniacal Salts.

Chalk

that made by the fixed (unleſs there was previouſly a volatile one in the menſtruum, as is the caſe when the Aqua regis is prepared with Sal ammoniac), bears to be ignited, and melted into Gold again, without the leaſt exploſion.

In like manner, Silver and Biſmuth diſſolved in Aqua fortis, and Copper in all acids, are totally and permanently precipitated by fixed alcalies; but either not precipitated at all, or readily diſſolved again by the volatile. Solution of Platina in Aqua regis is not precipitated totally, and ſolution of Zinc in Aqua fortis is ſcarcely precipitated at all, by either Alcali.

Mr. Marggraf has given ſome curious experiments on this ſubject, in the Memoirs of the Academy of Sciences of Berlin for the year 1745. He finds that volatile ſpirits (it was the common Spirit of Sal ammoniac he made uſe of) not only rediſſolve ſundry metallic bodies after having precipitated them, but diſſolve even the calces thrown down by fixed alcalies, after they have been ſeparated from the liquor, and freed as much as poſſible from their ſaline matter by ablution with hot water.

The calces of Gold, Silver, and Biſmuth, he ſays, diſſolved with eaſe: Thoſe of Tin, Lead and Quickſilver ſeemed to reſiſt theſe menſtrua; the volatile ſpirit having no effect when added in over-proportion to the liquor after precipitation, any more than when digeſted on the edulcorated Precipitates.

He obſerves, that the ſolution of Gold in volatile ſpirits depoſites the Gold on being expoſed to the air . . That Silver does not ſeparate from the liquor on ſuch expoſure, but that upon the exhalation of the ſuperfluous moiſture, it ſhoots into fine cryſtals, which diſſolve, by the aſſiſtance of heat, in rectified Spirit of Wine; from which they again concrete in the cold, into elegant cryſtallizations . . . That Sea-ſalt or its acid throws down Silver from its volatile alcaline ſolution, in form of a white Precipitate, but that the vitriolic acid produces no change . . That Mercury, added to this ſolution, unites with the Silver, and forms with it in a ſhort ſpace of time, the efflorescences called *Arbor Dianæ*.

We have formerly ſeen (page 476.) that fixed alcalies impregnated by calcination with the inflammable principle of animal ſubſtances, diſſolve thoſe metals nearly in the ſame manner as the volatile; and perhaps it is on the ſame principle that the diſſolving power of both alcalies in good meaſure depends, for volatile alcalies, however purified, are always found to participate of inflammable matter . . Gold and Silver ſeem to be acted on almoſt equally by both kinds of Alcali: Zinc diſſolves moſt readily in the fixed, and Biſmuth in the volatile: Quickſilver, though it reſiſts the volatile, diſſolves in the fixed, whilſt Lead and Tin ſeem to reſiſt both. There are ſome remarkable differences in the ſolutions made by the two kinds of Alcali: Thus the marine acid, which precipitates Silver from the volatile, occaſions no change in the ſolution of that metal made in the fixed Alcali.

VOLATILE SALTS.

Chalk and other calcareous earths likewiſe abſorb the acid from them when the mixture is expoſed to a conſiderable heat, the acid ſeeming to have a ſtronger attraction to the earth than to the volatile Alcali already combined with it. On varying the manner of application, the affinity ſeems to be juſt the reverſe: Diſſolve the Chalk firſt in any acid, and the addition of a volatile Alcali will precipitate it; as if the acid had the greateſt affinity to one by dry mixture in the fire, and to the other in the way of humid ſolution. The remarkable habitude of theſe Salts to Quick-lime has been examined in another place. (See page 222.).

Volatile Salts diſſolve in about four times their quantity of water, and make the liquor ſenſibly colder; whereas fixed alcalies render it ſomewhat warmer. On diſtilling the ſolution, the Salt condenſes about the ſides of the recipient in a cryſtalline form, uſually arranged into different ramifications, which ſome of the chemiſts have fancifully reſembled to the original horns of the Hart from which theſe kinds of Salts have been principally prepared.

Rectified Spirit of Wine has very little action on theſe Salts. If this Spirit be added to a ſaturated ſolution of volatile Salt made in water, it weakens the diſſolving power of that menſtruum, and a proportionable quantity of the Salt precipitates (*l*). Oils and Balſams unite with volatile alcalies by agitation into a ſemiſaponaceous liquid; eſſential Oils eaſily, the expreſſed difficultly.

Volatile ſpirits, or ſolutions of volatile Salts in water, diſſolve ſome metallic bodies, particularly Copper. Added to a ſolution of this metal made in acids, they precipitate a part, but ſoon take it up again, and render the liquor of a beautiful ſapphire-blue colour. Added to a ſolution of Mercury-ſublimate, they throw down the Mercury in form of a white powder. This laſt property is

(*l*) *Volatile alcalies precipitated from water by Spirit of Wine.*] This property affords a commodious method of diſtinguiſhing an abuſe, which has been often practiſed in trade, in regard to volatile ſpirits; namely, that of diluting them with a large quantity of water, and ſupplying the pungency, thus weakened, by the addition of a little of the penetrating cauſtic ſpirit made from Sal ammoniac or Urine with Quick-lime.

On mixing rectified Spirit of Wine with a genuine volatile ſpirit ſaturated with Salt, a part of the Salt inſtantly ſeparates in form of ſmall cryſtalline concretions; whereas the ſophiſticated ſpirits, containing little or no actual Salt, can exhibit no ſuch appearance.

Some have practiſed an impoſition, which though of a groſſer kind, eludes this method of trial. A ſolution of crude Sal ammoniac being mixed with a ſolution of Pot-aſh, the Pot-aſh abſorbs the acid of the Sal ammoniac, and ſets its volatile Alcali at liberty; and thus the liquor (eſpecially if acuated with a little of the ſpirit made with Quick-lime) acquires the ſame pungent ſmell with that of the pure diſtilled volatile ſpirits.

As this liquor contains a quantity of regenerated Sea-ſalt (compoſed of the Pot-aſh and the marine acid of the Sal ammoniac) and as this Salt is not diſſoluble in Spirit of Wine; it is plain that the counterfeit, on being mixed with that ſpirit, will ſuffer the ſame precipitation that the genuine volatile ſpirits do.

This abuſe may be diſcovered by evaporation, the genuine totally exhaling, whilſt the counterfeit leave a fixed Salt behind; or more readily, by adding to a little of the ſuſpected ſpirit, a drop or two of a ſolution of Silver made in Aqua fortis. This ſolution, as I have found on trial, mingles uniformly with pure volatile ſpirits, without producing the leaſt precipitation or turbidneſs, or untranſparency; whereas, if the ſpirit contains the ſmalleſt portion of Sal ammoniac, or Sea-ſalt, or regenerated Sea-ſalt, the two liquors grow white and milky the inſtant they are mixed. The foundation of this experiment is obvious from the foregoing note.

is one of the common criteria for diſtinguiſhing a volatile Alcali in liquors from a fixt; the latter throwing down from the ſolution of Sublimate, not a white, but an orange-yellow or reddiſh Precipitate. VOLATILE SALTS.

Volatile ſpirits are leſs active menſtrua for ſundry vegetable and animal ſubſtances, and for Sulphur in the mineral kingdom, than fixt alcaline Lixivia. This may be aſcribed in great part to their volatility; which renders them incapable of bearing the boiling heat that is in many caſes neceſſary for enabling fixt alcalies to act effectually.

Volatile Salts, mixed with Nitre and injected into a red-hot crucible, deflagrate and are deſtroyed. This experiment, which ſucceeds with the pure volatile Alcali of Sal ammoniac, as well as with thoſe which have a manifeſt impregnation of Oil, evinces that theſe Salts contain an actual inflammable matter as one of their eſſential principles; and agreeably to this, it may be obſerved, that no volatile Alcali is producible but from ſubſtances that participate of phlogiſton. They apparently contain alſo an earth; but what other principle or principles enter their compoſition, experiment has not hitherto determined.

II. LATENT ANIMAL ACID.

THIS acid, which has eſcaped the enquiries of many of the chemiſts, and whoſe exiſtence has even been denied, Mr. Homberg has ſhewn two ways of procuring. ACID.

One way is, by concentrating the phlegm which ariſes firſt in the common diſtillation of animal ſubſtances for their volatile Salt and Oil. This phlegmatic liquor being collected by itſelf, and rediſtilled with a gentle heat till only a ſmall portion remains, he finds the acid in this reſiduum; which acid he has ſometimes concentrated ſo far, that it ſeemed as ſtrong as common Vinegar. If the quantity of phlegm obtained in the firſt diſtillation is ſmall, it gives when concentrated only ſlight marks of acidity; where the quantity is greater, the acidity alſo is ſtronger, though in either caſe it is ſufficiently ſenſible.

The other method of collecting this latent acid is, by mixing earthy matters with the animal ſubject at firſt, and urging the diſtillation after all the alcaline Salt and Oil have ariſen. In this caſe, the acid does not come over with the phlegm, but in the liquor forced out at laſt by the greateſt vehemence of fire.

The nature and properties of this animal acid we do not know; nor is it certain that the acids obtained by the two proceſſes above-mentioned are entirely the ſame. Perhaps this acid may be no other than a part of the vegetable acid of the food, which has eſcaped the digeſtive powers of the animal; for it is diſcovered moſt remarkably in the blood, bones, *&c.* of thoſe animals who feed immediately on vegetables (*m*).

III. ANI-

(*m*) *Latent acid.*] Mr. Pott informs us (in the *Miſcellanea Berolinenſia*, *tom.* vi. *Ann.* 1740.) that the ſaline empyreumatic ſpirit, which comes over laſt in the common diſtillation of animal ſubſtances by an intenſe fire, leaves, on being rectified, an ammoniacal liquor, and that the liquor which ariſes in the rectification is alſo ammoniacal: For on the addition of a fixt Alcali, it diffuſes a ſtrong urinous ſmell, which was diſcover-

III. ANIMAL OILS.

OILS. THE Oils which ariſe in the diſtillation of animal ſubſtances have a ſtrong peculiar ſtench. Diſtilled a ſecond time in glaſs retorts, by a gradual fire, they leave behind a thick, black, pitchy matter, and thus become more fluid and leſs fetid. By repeated diſtillations, either by themſelves or with the addition of Quick-lime or other earthy powders to detain more effectually the groſs ſubſtance, their quantity is more and more diminiſhed, and their empyreumatic ſmell more and more deſtroyed; they become thin, colourleſs, of a ſweet taſte, and a grateful penetrating odour.

It is obſervable that theſe Oils diſſolve in Spirit of Wine, both when ſubtilized by theſe operations, and in their groſs fetid ſtate, though the animal ſubject that affords in diſtillation a large quantity of the Oil, if treated at firſt with ſpirit gives out little, or ſcarcely any thing, to that menſtruum. We ſhall ſee hereafter that it is ſtrictly the gelatinous matter of animals that yields theſe offenſive Oils; and of this matter the proper diſſolvent is not ſpirit but water.

Dippel, who firſt diſcovered the purification and ſubtilization of empyreumatic animal Oils by repeated diſtillations, recommends the Oils ſo rectified as medicines of great virtue. Theſe Oils, in effect, appear to poſſeſs a high degree of medicinal activity: Hoffmann relates, that two drops being diſſolved in half an ounce of rectified Spirit of Wine, and the ſolution given to four men, (that is, only half a drop to each) this ſmall quantity procured in them all a copious ſweat (*n*).

The empyreumatic Oils diſtilled from different animal ſubſtances are not entirely the ſame like the volatile Salts: Of many of them, the ſmell is very obviouſly different, not only in degree but in kind. Their particular properties have as yet been very little examined, few experiments having been made upon theſe fetid ſubſtances, except by thoſe who have buſied themſelves in ſearching for alchemical myſteries in the excremental parts of animals. Whether by rectification they all become perfectly ſimilar, as volatile Salts do, is unknown.

Animal

able only in a low degree before; and the Alcali ſhoots into cryſtals, a mark that it has abſorbed an acid. By this method, he ſays, an acid principle may be demonſtrated in all the parts of animals. He obſerves likewiſe, that the Caput mortuum or coal remaining after the diſtillation of blood, yields on being diſtilled with Vitriol or Bole, an acid ſpirit agreeing in all reſpects with that of *common Salt*; and this though the animal uſes no common Salt in its food.

May it not be preſumed, that the acid diſcoverable in animal ſubſtances by theſe kinds of operations, is really no other than the acid of the marine Salt which we have elſewhere ſeen that thoſe ſubſtances participate of?

(*n*) *Animal Oils of great medicinal activity.*] It is in conſequence of the virtue of the Oil, that volatile animal ſpirits differ as medicines from the pure Spirit of Sal ammoniac. In the rectification of animal ſpirits for medicinal uſe, the intention is not to purify them wholly from the Oil, but to ſeparate the groſſer part, and ſubtilize the reſt, and thus bring it towards the ſame ſtate as when the Oil is rectified by itſelf. I have repeated the rectification of Spirit of Hartſhorn twenty times ſucceſſively, and found it ſtill to participate of Oil, but of an Oil very different from what it was in the firſt diſtillations.

Animal Oils differ greatly and obviouſly from the vegetable; and even the inflammable matter which remains fixed in the black coal left in the diſtillation, after the expulſion of all the Oil that the greateſt vehemence of fire is capable of expelling in cloſe veſſels, appears to be different in the two kingdoms. Fixed alcaline Salts, calcined with coals, extract a part of this inflammable matter, and render it ſoluble along with themſelves in water: Animal coals have this particularity, that when the Alcali has been calcined with theſe, the ſolution precipitates from a ſolution of green Vitriol the pigment called Pruſſian-blue, and has different effects on other metallic ſolutions alſo from other kinds of alcaline Ley. OILS.

IV. ANIMAL EARTH.

ANIMAL ſubſtances, or the black coal remaining after the diſtillation of them, on being burnt with a ſtrong fire in open veſſels, are diveſted of all their volatile and combuſtible matter, and reduced into a white earth. The hard parts, as bones and horns, ſtill retain their original figure; and inſtead of falling into aſhes like vegetable matters, preſerve ſome degree of hardneſs: Hence their thorough calcination is more difficult than that of vegetables, the external part of the maſs defending the internal from the air. EARTH.

The properties of the earths obtained by this proceſs from animal and vegetable ſubſtances have been little examined. Thus much however, the experiments that have been made upon them, are ſufficient to demonſtrate, that the earths of the two kingdoms are of a quite different nature from one another. Their differences are moſt remarkable in their habitude to vitrification.

The vegetable earth vitrifies with eaſe, and gives a green tinge to its glaſs, which ſometimes is very beautiful. The animal earth is extremely refractory, and is ſcarcely at all to be brought into perfect fuſion, in the common furnaces at leaſt, by the moſt active fluxes: When mixed with the vegetable earth, or with different vitreous fluxes, in ſuch quantity as not to prevent the fuſion of the flux, it gives an opake milkineſs to the glaſs, like that of fine porcelane or white enamel; the animal calx ſeeming to be only diffuſed through the maſs without alteration of its form, juſt as it would be diffuſed through water by agitation. From this property of animal earths, they are employed in the compoſition of milk-white or porcelane-like glaſſes (*o*).

SECT.

(*o*) *Animal earths.*] In the animal kingdom we meet with three kinds of earth, apparently diſtinct from one another.

1. The Earth of the *Shells of ſea-fiſhes* appears to be nearly of the ſame kind with Chalk and the mineral calcareous earths. By calcination, it is changed into a true Quick-lime, in ſome reſpects ſtronger than the mineral Limes. It diſſolves readily and perfectly in the nitrous, marine, and vegetable acids; but not at all, or only in an inconſiderable quantity, in the vitriolic. When previouſly diſſolved in other acids, it is precipitated on the addition of the vitriolic, into a concrete no longer diſſoluble in any, and which is found to be ſimilar to the Selenitæ which the mineral calcareous earths produce upon the ſame treatment. This earth is extremely refractory in the fire: It does not perfectly vitrify (at leaſt if its proportion is conſiderable) either with Salts or with metallic glaſſes; and in this reſpect it differs from the calcareous earths of the mineral kingdom.

2. The

SECT. III.

INSECTS.

INSECTS. AMONG the infinite variety of infects, generated ſo abundantly in the different parts of nature, on vegetables, on the bodies of larger animals, in putrid vegetable and animal ſubſtances, and in the earth; there are few which have hitherto been chemically examined, or applied to any conſiderable uſes, in medicine or in arts. The principal are, Cantharides, Ants, Earth-worms, Millepedes, and Cochineal.

I. CANTHARIDES. CANTHARIDES are a beautiful kind of fly or winged inſect, of a bright, ſhining, greeniſh-golden colour, with ſome admixture of bluiſh. They were formerly brought from Spain, and hence are ſtill commonly called Spaniſh flies. They are not, however, peculiar to that kingdom: France, ſome parts of Germany, and other countries, produce abundance. It is principally in the ſpring, and on poplar and aſh-trees, that they are met with.

The

2. The Aſhes of *Bones* and *Horns* agree with the preceding in being eaſily ſoluble in the nitrous, marine and vegetable acids, and not in the vitriolic; and in their being precipitated by the latter from other acids into a ſelenitic concrete. They agree alſo in their reſiſtance to vitrification: I have tried in vain to vitrify them by the addition of other earths, as well as of Salts and metallic glaſſes: Fuſible earthy mixtures (See the firſt part of this work) by which all the earthy and ſtony bodies I know of in the mineral kingdom except the precious ſtones, would in certain proportions have been brought into fuſion, were by the ſame and by ſmaller proportions of calcined Hartſhorn and of calcined Bones, either prevented from melting at all, or rendered opake and milky .... The difference of theſe earths from the preceding, and the only difference I have obſerved, is, that they are not changeable by fire into Lime: How ſtrongly ſoever the earth of Bones and Horns be calcined, it continues inſipid, and gives no manifeſt impregnation to water.

3. The Aſhes of *Blood*, *Skin*, and *Fleſh*, differ from the earths of the firſt kind in not being convertible into Lime; and from both the firſt and ſecond in being diſſoluble, readily and perfectly and plentifully, in the vitriolic acid as well as in the nitrous and marine. In both theſe reſpects they agree with the incinerated earth of vegetables: They differ from that earth in the nature of the compound which they form with the vitriolic acid; the animal earth diſſolving into an auſtere aſtringent liquor approaching to an aluminous nature; the vegetable into a bitter purgative one ſimilar to the purging mineral waters. The habitude of this ſpecies of animal earth to vitrification, I have not tried.

The earth into which animal ſubſtances are reſolved by putrefaction appears to be one and the ſame whatever ſubject it was produced from; and not to differ ſenſibly from vegetable mould. It is indiſſoluble in acids, ſomewhat tenacious when moiſtened with water, friable when dry, and acquires no additional hardneſs in the fire. The habitude of either the vegetable or animal mould to vitrification is not known.

The usual way of killing them is by the steam of strong or distilled Vinegar (*p*). The flies are put into a clean pot, which is covered with a haircloth, and then inverted upon another pot containing the Vinegar warmed by a little fire made underneath; the juncture of the two pots being closely luted, to confine the steam. The flies are afterwards thoroughly dried, and packed up secure from the air. In long keeping, they fall by degrees into a greyish or brownish light powder, and in this state are unfit for use, their intrinsic qualities perishing with their external form. The wings are the most permanent part, these remaining entire after the body of the fly has mouldered into dust. CANTHARIDES.

Cantharides, when fresh, have a strong fetid smell: Tasted, they make at first no impression upon the tongue, but in a little while they discover a degree of acrimony and a kind of pitchy flavour. Applied to the skin, they raise a blister on the part. The usual blistering plasters are composed of powdered Cantharides and some common plaster, in the proportion of one part of Cantharides to two, six, eight or more of the plaster, according as the composition is required to be more or less active.

Taken internally, in the dose even of a few grains, they generally occasion violent irritation and inflammations. They act in a peculiar manner upon the kidneys, and the urinary and seminal vessels: When applied only externally as a blister to remote parts, they often affect the bladder, and bring on a difficulty and pain in making water. They are nevertheless given inwardly in small doses, both with safety and advantage, in some refractory disorders, which baffle the force of medicines of less activity. Dr. Grœneveld, who was imprisoned, in England, for having ventured to exhibit them, published a treatise in defence of his practice and of the utility of the medicine. He employs Camphor for correcting the virulence of the Cantharides; but for my own part, I should have little dependance upon that corrector: The best remedies against the ill effects of this, as of other stimulating drugs, are, Milk and expressed Oils.

The stimulating power of Cantharides is ascribed by many to an acrimonious caustic Salt. But experiment discovers in them no saline principle of any kind, till they have undergone the destructive action of fire. By the action of a strong fire, a volatile alcaline Salt is producible equally from all animal substances; the same Salt, and no other, is obtained from Cantharides. It is pretty remarkable, that those who deduce the virtue of this insect from an imaginary Salt, employ, for extracting its virtue, not water which is the direct and proper menstruum of Salts, but vinous spirits; and thus, in their practice, contradict their own theory.

Others,

(*p*) *Killed by the steam of Vinegar.*] Vinegar should seem not to be very proper for this use, for the steam which arises from it in a gentle heat can scarcely act any otherwise upon the insect than as a watery vapour. Vinous spirits, used among us for the curation of millepedes, appear to be the best calculated for the curation of Cantharides also, and of other insects, as the colouring ones Kermes and Coccus Polonicus; the steam of Spirit of Wine, or the liquor itself sprinkled upon them, not only soon killing the insects, but embalming as it were, and preserving them from decay.

CANTHARIDES.

Others, in order to account for the ſingular qualities of this inſect, have had recourſe to its mechanic ſtructure; to its ſharp, pointed, needled, ſword-like particles, lacerating the parts of animal bodies which they come in contact with. The microſcope indeed diſcovers ſome fine pointed filaments on the belly of the fly: But theſe are only hairs, too ſoft and flexible to wound or injure the ſkin. Cantharides communicate all their activity to vinous ſpirits, without loſing any thing of their form: Bare pulverization deſtroys their ſpicular appearance, without abating their acrimony or cauſticity. It is not by virtue of their mechanic ſtructure, but of their intrinſic properties, that they ſtimulate, lacerate and corrode.

If we may be allowed, in analogy to the vegetable kingdom, to apply the name of *reſinous* to that principle in animal ſubſtances which rectified Spirit of Wine diſſolves; the native principles of Cantharides are, a reſinous, gelatinous, and earthy matter; and the principle, in which their activity ſolely and wholly reſides, is the Reſin.

Four ounces of the flies, boiled in water, gave two ounces, all but two ſcruples, of gelatinous extract; after which, rectified Spirit extracted twenty-eight grains of Reſin, the indiſſoluble earthy reſiduum weighing two ounces and one ſcruple. The ſame quantity of the flies, treated firſt with ſpirit, yielded ſix drams two ſcruples of reſinous extract; and afterwards with water, three drams twelve grains of a gelatinous one: The reſiduum amounted here to ſix drams more than in the former way of extraction (*q*).

The reſinous extract is acrid and nauſeous to the taſte, and bliſters the ſkin like the fly in ſubſtance; whilſt the gelatinous matter, freed from the reſinous, proves like the earthy part, inſipid and inactive (*r*). In diſtillation, rectified ſpirit brings over little or nothing: The diſtilled water has a conſiderable ſhare of taſte and ſmell, but exhibits no appearance of Oil.

Three ounces of Cantharides diſtilled in a retort in an open fire, gave over one ounce of urinous ſpirit, two drams of empyreumatic Oil, and two drams ten grains of volatile Salt. The Caput mortuum weighed ten drams; and on being calcined and elixated, yielded ſcarcely a grain of ſaline matter——It is plain from

(*q*) *Cantharides with water and ſpirit.*] This inſect communicates nothing of its fine green colour to either of theſe liquors. The watery tincture is of a muddy yellowiſh or browniſh, and the remaining fly appears to have loſt conſiderably of its beauty. The ſpirituous tincture is of a bright yellow, but leaves the Cantharides of brighter and more beautiful colours than they were at firſt.

There are many other animal ſubſtances, that glow with ſuperficial colours, which chemiſtry has not been able to ſeparate or extract. The coloured ſhells and furs, and the plumage of birds, give out nothing of their colours to any known menſtruum.

(*r*) *Gelatinous part inactive.*] Though the activity of the Cantharides may be properly ſaid to reſide in that part which Spirit of Wine diſſolves; yet this matter ſeems to be totally extracted by water, as well as by ſpirit, the gelatinous ſubſtance rendering the other ſoluble in water, in the ſame manner as the gummy parts of vegetables do the reſinous. An extract made by water, an extract made by ſpirit, and the flies remaining after both proceſſes reduced into fine powder, were applied at the ſame time to the arm of the ſame perſon: The two extracts bliſtered, ſo far as could be judged, equally, and as effectually as Cantharides in ſubſtance: The two reſidua were equally inactive; they did not inflame, or irritate, or ſenſibly affect the ſkin, in twenty-four hours.

from this analyſis, that the acrimony and medicinal activity of Cantharides can have no dependence on the volatile Salt; for we ſhall ſee hereafter, that much larger quantities of Salt are obtainable from ſubſtances entirely inſipid and inactive, as raw Silk, Hair, Feathers, *&c.* CANTHARIDES.

II. ANTS.

THE ANT, noted by the naturaliſt for its agility and induſtry, and its extraordinary care of its eggs as they are called, in conveying them into the ſun ſo often as he ſhines, and as diligently carrying them off upon his disappearance or on the approach of rain; affords likewiſe ſome remarkable phænomena to the chemical obſerver.

Volatile acid ſmell.

On turning up an Ant-hill in ſpring or ſummer, the firſt thing perceived is a ſtrong volatile ſmell, affecting the noſe nearly in the ſame manner as Spirit of Hartſhorn or of Sal ammoniac. This vapour is not, however, as ſome have too haſtily affirmed, ſimilar in quality to thoſe alcaline ſpirits: It is truly of an acid nature, and like the other ſubſtances of that claſs, changes the colour of blue flowers, as Violets, Borage flowers, *&c.* to a red.

Reſin in Ant-hills.

On ſearching the Ant-hill, we commonly find pieces of a reſinous ſubſtance. This was ſuppoſed formerly to poſſeſs peculiar virtues, and diſtinguiſhed by the names of wild Frankincenſe, *Suffimentum ſylveſtre*, *thus Germanicum*, *maſtix & electrum formicarum*. It looks, taſtes, and ſmells, like the common Reſin of the Fir-tree, and in effect it is no other. It is about the roots of old Fir-trees that Ants principally lodge; and it is in ſuch lodgments, that the Reſin is principally met with. For what purpoſe they collect it, I do not pretend to know.

Their food.

I examined, in June, above thirty Ant-hills, but did not at that ſeaſon find any of the corn or grain which they are ſaid to lay up ſo plentifully for winter proviſion. It is not indeed on grain, but on the ſweet juices of vegetables, and the fleſhy parts of animals that they ſeem to feed. A little Honey or Cheeſe, placed near them, will ſoon collect a ſwarm of Ants, and by this method they may be catched in great numbers. They deſtroy ſome kinds of Caterpillars on trees and on culinary plants. If a Mouſe, Frog, or other like animal be placed in an Ant-hill, he will be devoured in a few days to the bones and ligaments.

Exquiſite ſkeletons of ſmall animals.

Hence we are furniſhed with a method of obtaining ſkeletons of thoſe animals, exquiſitely beautiful and perfect, far ſurpaſſing any thing that can be executed by artificial anatomy. The ſubject is for this purpoſe to be incloſed in a wooden box, and properly diſtended, to prevent the parts from collapſing or being cruſhed together by the earth: The box is to be perforated with a number of holes, through which the inſects will preſently find their way.

Acid of Ants.

The pungent vapour obſerved on ſtirring up an Ant-hill, does not proceed from any heterogeneous ſubſtances, but from the Ants themſelves. If a parcel of clean, live, vigorous Ants be ſtirred with a rod, ſo as to greatly irritate and exaſperate them, they diſcharge a ſimilar acid juice, which may be plainly ſmelt and taſted upon the ſtick. If they are thus agitated and irritated in a veſſel of water or of Spirit of Wine, they impregnate the liquor with their acidity.

A part of this acid is ſubtile and volatile, a part groſſer and more fixed. The firſt ariſes in diſtillation with rectified Spirit of Wine, the latter not:

ANTS. Thus, if a conſiderable quantity of the ſpirituous infuſion, the diſtilled liquor will give ſenſible marks of acidity, but will not be near ſo ſtrongly acid as the remainder; and hence we are enabled to concentrate this animal acid. Water alſo brings over at firſt only the more ſubtile part, but if the diſtillation be protracted, the whole of the acid ariſes at length along with the water, as appears from the following experiment.

Analyſis. I diſtilled in a retort without addition two parcels of Ants; one conſiſted of Ants from which water had been previouſly abſtracted in *balneo mariæ*, and which had afterwards been exſiccated; the other of freſh Ants. Twenty-four ounces of the firſt yielded four ounces and a half of empyreumatic Oil, three ounces and a half of urinous ſpirit, two drams and a half of concrete volatile Salt, one dram of fixed alcaleſcent Salt, and eight ounces of earth, without giving any mark of acidity throughout the whole proceſs. The ſame quantity of freſh Ants on the other hand, gave over firſt of all eleven ounces and two drams of an acid ſpirit, afterwards ſix ounces ſix drams of an urinous one, one ounce and a half of empyreumatic Oil, and a dram and a half of concrete volatile Salt: The remaining earth weighed nearly three ounces, and yielded half a ſcruple of fixed Salt——It is plain from hence, that the acid of Ants is capable of being wholly elevated by diſtillation with water even in *balneo mariæ*.

The groſs acid is as ſtrong as good Vinegar: It changes Syrup of Violets red; effervesces with alcaline Salts and precipitates ſubſtances diſſolved by them; diſſolves abſorbent Earths, Iron, and ſeveral other metallic bodies.

Mr. Hook obſerves that ſome other inſects which are furniſhed with ſtings, as Bees, Waſps, Hornets, are furniſhed alſo with an acid juice, which they diſcharge upon being irritated; but none yield ſo large a quantity as Ants. Ants in their *chryſalis* or maggot ſtate have no acid; no marks of any having been diſcovered on diſtilling a quantity of the eggs.

Eſſential Oil. Another very extraordinary phænomenon occurred in a chemical examination of this inſect. Having diſtilled off ſome rectified Spirit of Wine from a quantity of Ants, and cohobated the ſpirit upon two or three freſh parcels, I found ſwimming upon the diſtilled liquor, a fine, clear, eſſential Oil.

Eſſential Oils are extreme rarities in the animal kingdom: There are only ſome ſubſtances of the unctuous kind that yield any thing like one: The Oils obtained from theſe are rather thin Fats than true Oils; and ſuch as they are, they do not ariſe without a conſiderable fire, whilſt this Oil came over with highly rectified ſpirit in the heat of a water-bath. I ſuſpected therefore that it was no animal Oil; that it proceeded from ſome ſmall bits of wood or of the reſinous ſubſtance above-mentioned, from which the Ants had not been ſufficiently cleanſed. The ſmell and taſte ſeemed likely to determine this; and here again I was ſurprized, to find that it had nothing of the pungency or heat which accompanies the Oils of Reſins and Woods. For further certainty in this point, I made a freſh diſtillation from Ants very carefully picked, and well waſhed with ſpirit: I diſtilled alſo ſome ounces of the Reſin with Spirit, in the heat of a water-bath, after the ſame manner as the Ants. The Ants yielded as before an eſſential Oil, whilſt the Reſin gave over ſome flavour to the ſpirit, but no viſible Oil. It was now evident, that the Oil did not proceed from

hetero-

heterogeneous matters adhering to the Ants: But there was ſtill a poſſibility that it did not pre-exiſt in the inſect. When Spirit of Wine is diſtilled with the vitriolic acid, an Oil is extricated from the ſpirit: It was poſſible that the acid of Ants might have here produced a ſimilar effect. I therefore diſtilled another parcel of well cleanſed Ants, with pure water inſtead of ſpirit: The experiment was fully deciſive: I ſtill obtained the ſame Oil, a truly animal eſſential Oil (*s*). ANTS.

Ants

(*s*) *Eſſential Oil and acid of Ants.*] Mr. Marggraf, in the Berlin Memoirs for the year 1749, has given ſome further obſervations on theſe ſingular products, and diſcovered alſo another principle in the Ant, no leſs rare in the animal kingdom, an Oil of the expreſſible kind, ſimilar to the expreſſed Oils of vegetables.

A quantity of live Ants was put into water, and diſtilled in a glaſs retort with a fire gradually raiſed to ebullition: In the receiver was found an acidulous liquor, with an eſſential Oil ſwimming upon it, as diſcovered by Neumann. This Oil had a peculiar ſmell, but no burning taſte: Mixed and digeſted with Salt of Tartar, and with iron filings, it gave no mark of acidity: It totally diſſolved the ſolid Phoſphorus of Urine, but without becoming luminous: It united with Spirit of Wine that had been diſtilled from fixed alcaline Salt, but did not mingle with a ſpirit rectified *per ſe*.

The acid decoction, which remained in the retort, being preſſed out from the Ants, there appeared upon its ſurface an oily matter; the quantity of which was found, in repetitions of the experiment, to be at leaſt an ounce and a half or two ounces from ſix quarts of Ants. This Oil was of a reddiſh-brown colour, and ſmelt a little of the inſect: In a temperate air it appeared fluid and tranſparent, but in a moderate froſt it became thick and opake: Like other expreſſed Oils, it burnt with a wick; ſwum on water, and refuſed to mingle with it; did not unite with the moſt highly rectified Spirit of Wine; did not ariſe in diſtillation with water; diſſolved Sulphur by boiling; formed a plaſter with calx of Lead, and a perfect Sope with alcaline Salts.

The acid decoction, freed from the Oil, was diſtilled in a retort placed in ſand: The receiver was changed as ſoon as the drops came over very acid; and the proceſs diſcontinued as ſoon as they became empyreumatic. By this means was obtained a liquor both in ſmell and taſte highly acid; the thick black Caput mortuum remaining alſo conſiderably ſo.

Properties of the acid of ANTS.

THE acid of Ants effervesces with alcaline Salts, both fixed and volatile. With volatile alcalies it forms a neutral liquor, which (like that compoſed of the ſame alcalies and Vinegar) yields no concrete Salt in diſtillation.

With fixed alcalies it concretes, upon proper exhalation, into oblong cryſtals, which deliquiate in the air. The cryſtals, or the ſaturated neutral liquor uncryſtallized, on being diſtilled with a fire increaſed till the retort begun to melt, yielded a liquor ſcarce ſenſibly acid, and afterwards a ſmall quantity of an urinous and partly ammoniacal liquor. The remaining black matter, diſſolved in diſtilled water, filtered and evaporated, ſhot into large cryſtals, of a particular figure, and which did not liqueſy in the air, though they were in taſte ſtrongly alcaline, effervesced with acids, and had all the other properties by which fixed alcalies are diſtinguiſhed.

This acid diſſolves, with great effervescence, Coral, Chalk, and Quick-lime; and concretes with them all into cryſtals, which do not deliquiate in the air.

It does not precipitate Silver, Lead or Mercury from the nitrous acid; nor Quick-lime from the marine. Hence it appears to have no analogy to the marine or vitriolic acids; the firſt of which conſtantly precipitates the metallic ſolutions, and the other the earthy.

It does not act upon filings of Silver; but (like vegetable acids) it totally diſſolves, by the aſſiſtance of heat, the calx of Silver precipitated

ANTS. Ants have been employed medicinally as an ingredient in baths for weakneſs of the nerves, rheumatic, paralytic, and other like complaints. Vinous ſpirits, impregnated by diſtillation with their volatile parts, have been applied externally to the ſame purpoſes, and likewiſe taken internally, as attenuants, corroborants, and aphrodiſiacs. Many other preparations of this inſect for the like uſes are deſcribed in the old books of pharmacy.

Deſtroyed. Ants are deſtroyed by ſtrewing a good quantity of unſlaked Lime about their hills: Some make uſe of Quickſilver, as a general poiſon to inſects. It is ſaid that they fly from Chalk, and from Ants that have been burnt; but on trial, I could not find that they did.

III. EARTH-WORMS. EARTH-WORMS are inhabitants of moiſt fat grounds, and are rarely or never ſeen in dry ſands: After rains, they come up to the ſurface, to enjoy the moiſture, and there they often fall a delicious prey to different kinds of birds (*t*). It is only when the ſurface of the earth is moiſtened by artificial watering, by rain, or the dew in ſummer-evenings, that we catch them: Some employ for watering the ground a decoction of Hemp-ſeed or of Walnut leaves: The Worms have great ſenſibility of any motion of the earth about them from a rude approach, and in the twinkling of an eye are ſunk into their holes again. They can ſcarcely bear any ſaline ſubſtances, except thoſe of the nitrous and urinous kind: A ſolution of Vitriol, or of common Salt, or alcaline Ley, poured

cipitated from Aqua fortis by Salt of Tartar.

It does not diſſolve calces of Mercury, (as vegetable acids do) but revives them into running Quickſilver.

It acts very weakly upon filings of Copper, but perfectly diſſolves Copper that has been calcined. The ſolution yields beautiful, compact, green cryſtals.

It diſſolves iron filings with violence. The ſolution, duly evaporated, ſhoots into cryſtals, more readily than that made in diſtilled Vinegar.

It ſcarcely acts at all upon calces or filings of Tin.

It does not, according to Mr. Marggraf, corrode filings of Lead; but diſſolves by the aſſiſtance of heat, the red calx of Lead. The ſolution cryſtallizes into a *Saccharum ſaturni* . . . In Mr. Ray's philoſophical letters it is ſaid, that "*Lead* put into "the acid ſpirit, or fair water together with "the animals themſelves being alive, makes "a good *Saccharum ſaturni*," and that this Saccharum on being diſtilled "will afford "the ſame acid ſpirit again, which the *Sac-*"*charum ſaturni* made with Vinegar will "not do, but returns an inflammable Oil "with water, but nothing that is acid: "And *Saccharum ſaturni* made with Spirit of "Verdegris doth the ſame in this reſpect "with Spirit of Piſmires."

It diſſolves Zinc with vehemence; and ſhoots, upon duly evaporating the ſolution, into elegant cryſtals, not at all like thoſe produced with diſtilled Vinegar.

It ſeems to have little effect upon Biſmuth or Regulus of Antimony, either in their metallic form, or when reduced into calces.

From theſe experiments it appears, that this acid has a great analogy with that of Vinegar, though in ſome reſpects it is different.

(*t*) *Earth-worms as food for birds.*] Mr. de Reaumur propoſes the collecting of Earth-worms for feeding domeſtic fowls, in the room of grain. He computes, that the quantity of Worms lodged in the earth is greater than the ſum total of every kind of grain reaped by men. He obſerves, that during the whole courſe of the year they make greateſt part of the food of numerous kinds of birds, many of which have in winter ſcarcely any other reſource; and that there would ſtill remain enow for the wild birds, if we were to give all our domeſtic fowls no other aliment.

poured into their holes kills them; but that nitrous and putrid matters are not offenſive to them, appears from their loving dunghills. Their food is the young and the corrupted roots of plants. EARTH-WORMS.

Earth-worms are cleanſed, for medicinal uſe or chemical experiments, by waſhing, and then ſuffering them to creep through coarſe woollen cloths. Unleſs haſtily dried, by the heat of the ſun or of common fire, they are very apt to putrefy, on account of their copious ſlimy juice, Moiſtened with Wine or with vinous ſpirits to prevent their putrefaction, and ſet in a cellar in a wide-mouthed glaſs, they are almoſt wholly reſolved in a few days, into a ſlimy liquor. Stahl ſuppoſes that they are impregnated with a nitrous Salt, which they receive from the putrid matters they live among: When the liquamen or diſſolution of the Worms is mixed with a little fixed alcaline Salt, and after due evaporation ſet by to ſhoot, the cryſtals are no other than Saltpetre.

On digeſting dried Earth-worms in freſh parcels of rectified Spirit of Wine, ſo long as they communicated any tinge to the menſtruum, and then inſpiſſating the tinctures together by a gentle heat; I obtained, from four ounces of the Worms, ſix drams of extract: The reſiduum dried and treated with water, gave out three drams and a ſcruple. The ſame quantity of the dry Worms, treated at firſt with water, yielded one ounce ſix drams and a ſcruple; after which, rectified ſpirit extracted two ſcruples. So that the quantity extracted by water is not only greater than by rectified ſpirit, but the collective quantity extracted by both menſtrua is greater when water than when ſpirit is applied firſt.

Thirty-two ounces of dried Earth-worms, diſtilled in a retort without addition, by an open fire, yielded thirteen ounces and a half of volatile urinous ſpirit, one ounce of concrete volatile Salt, and four ounces and a half of empyreumatic Oil: The remainder, burnt in the open air, and elixated with water, gave an ounce and a half of fixed alcaline Salt: The earthy part weighed ſix ounces and a half. If the inſects be putrefied previous to the diſtillation, they give over almoſt mere phlegm, or only a very little Oil and volatile Salt.

Earth-worms are ſuppoſed by ſome phyſicians to be antiſpaſmodic and diuretic: In caſes where ſuch medicines are required, they have been given in powder, from fifteen grains to a ſcruple. What medicinal virtues they really poſſeſs, it is not my province to enquire; but whatever theſe virtues may be, it is in the fixed and not in the volatile parts that they reſide: The diſtilled water and ſpirit, though greatly recommended by ſome, are entirely inſignificant, as having no impregnation from the Worms.

Earth-worms burnt to blackneſs in a cloſe veſſel, are ſaid to be more ſerviceable in nervous caſes, than in their natural ſtate, or than ſuch preparations of them as have not ſuffered a like change from fire; and ſundry other animal ſubſtances, prepared in the ſame manner, are ſuppoſed to acquire ſimilar antepileptic virtues. Theſe kinds of preparations are not to be conſidered as poſſeſſing any of the ſpecific qualities of the ſubject from which they were made; but as an animal coal, not diveſted of thoſe principles which a longer continuance of the fire would have more completely formed and extricated from it. The medicinal effects of ſuch a coal, in which the volatile Salt is juſt as it were a forming, are not perhaps much known, any more than its chemical properties.

MIL-

IV. MILLEPEDES. MILLEPEDES or Woodlice are oblong insects, commonly as long again as they are broad; flat and whitish on the belly; somewhat convex, and of a paler or darker brown colour, on the back; and indented about the sides like a saw. The number of feet, though their usual Latin name *Millepedes* expresses their having a thousand, is only fourteen, seven of which are on one side, and as many on the other. The back is composed of joints, like a Lobster's tail; by means of which, the animal contracts itself into a globular form on being touched, or on the apprehension of any danger. The eggs are white and glistening, like little Pearls.

They are met with in moist places, as in cellars, about old rotten wood, about water-troughs, under timber and stones that have lain long on the ground unmoved. Their size is different in different places and countries: Those found about houses are larger than in the cavities of trees in woods, and those of France larger than those of Germany: The largest are the best. Snakes, Lizards, Frogs and Toads devour them.

Watery liquors extract from this insect, as from the foregoing, considerably more than spirituous ones; though the quantity of matter, soluble in either, is not near so large in the Wood-louse as in the Earth-worm. From an ounce of Millepedes I obtained by water four scruples and fifteen grains of extract, whilst the same quantity, treated with rectified spirit, gave but two scruples and twelve grains. After the spirit would extract no more, water took up two scruples and five grains: But the Millepedes that had been first digested with water, gave out to spirit only half a scruple. The indissoluble matter, remaining after the action of both menstrua, weighed when spirit was applied first, six drams four grains; when water was first applied, five drams and a half.

Four ounces of Millepedes, distilled in a retort with an open fire, gave over ten drams and a half of urinous spirit, three drams and a half of empyreumatic Oil, and a scruple of concrete volatile Salt: From the remaining coal, burnt in the open air, and elixated with water, were obtained three scruples and a half of fixed alcaline Salt, and two ounces of earth. A little more volatile Salt may be separated from the spirit: But the quantity does not, in all, amount to near so much as Lemery makes it: If no mistake was made in his experiment, the Millepedes of France must be different in quality from those of Germany which I examined.

It is commonly supposed that this insect contains a nitrous Salt, from its living in cellars, and other places imagined to be impregnated with Nitre. No such Salt, however, is to be discovered by experiment, either in the Millepedes themselves, or in the earths where they are found.

Millepedes are celebrated medicinally as resolvents and diuretics; and supposed to have this peculiar advantage, that whilst they effectually promote urine and attenuate viscid juices, they occasion no immoderate heat or exagitation of the humours: It may be questioned, perhaps, whether this quality is deduced from fair experience, or from the conceit of their being impregnated with a nitrous Salt.

The powder of Millepedes is said to be less efficacious than the fresh insect, or its juice, or an infusion of it in Wine or in vinous spirits. Whatever the Mil-

Millepedes may loſe in being dried and powdered, it is pretty clear that nothing of their virtue ariſes in diſtillation; for neither the diſtilled water nor ſpirit have any ſmell or taſte. MILLEPEDES.

V. COCHINEAL. Its general hiſtory.

COCHINEAL is a ſmall, irregular, roundiſh body, internally of a red colour. It is brought chiefly from New Spain, and there collected from a plant, which is now common in the botanic gardens of Europe, called *Opuntia* or prickly Pear-tree.

It was formerly ſuppoſed to be the entire fruit or berry of the tree, wrinkled and ſhrivelled by drying: When the Pear itſelf became known, Cochineal was ſuppoſed to be its ſeeds; but it differs greatly from theſe alſo, as well as from the entire Pear. It is now known with certainty, to be not a vegetable but an animal ſubſtance; to be a particular ſpecies of inſect, produced upon the tree. Acoſta was one of the firſt eye-witneſſes of its being an inſect; and Sir Hans Sloane, Plumier, and all the later travellers into America, confirm his account.

To what claſs of inſects Cochineal belongs, has been diſputed; ſome affirming that it has ſix feet, and no wings, and reſembles a Bug; others, that it has four wings, and is a ſpecies of *Scarabæus* or Lady-bird; others, that like ſeveral kinds of Caterpillars and Worms, it has neither wings nor feet; and others, that it is an inſect in its imperfect or *chryſalis* ſtate, incloſed in a pellicle or huſk. All theſe opinions are in part true: The Cochineal inſect, like many others, goes through a variety of forms; though the rich red colour, for which it is valued, it poſſeſſes only in one of them. On examining carefully ſeveral hundred weights of Cochineal as brought to us, I have ſeen ſome grains in all the ſtates above-mentioned.

In its advanced ſtate, it is a ſmall ſcarabæus, or ſheath-winged inſect with ſix feet: The body is roundiſh, hemiſpherical on the upper part, flat underneath, full of circles or rings, of a blackiſh-brown colour: The covers of the wings are red, with a yellow ſpot on each. The ſcarabæus depoſites on the leaves of the Opuntia, ſmall eggs, from each of which comes forth a little inſect, reſembled to a Flea or Tick. When this increaſes, it looks like a Worm or Caterpillar, with ſix ſmall feet, ſcarcely to be ſeen, on the forepart of its body: It crawls among the leaves, and chuſes ſuch ſituations, where it may be beſt ſecured from rain and other inclemencies of weather. After theſe have attained to their full growth, they contract themſelves, and at the ſame time become redder and redder: A pellicle is formed all over them, and they adhere motionleſs, as if fixed with Glue, upon the leaves, which now look as if covered with fine red berries. This ſtate continues about ten or twelve days, when the huſk opens, and diſcovers a winged ſcarabæus again, which has very little of the deep red colour of the Maggot or *chryſalis*. The ſcarabæus lays its eggs, and then ſucceed the ſame transformations as before.

Great care is taken in the preſervation and curation of theſe valuable inſects; in defending them from rain, cold, heat, from being preyed on by birds, *&c.* in houſing them at certain ſeaſons, and in collecting and drying them for uſe: The particular methods, followed for theſe purpoſes, are not certainly known.

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Cochineal. The inſect is doubtleſs collected in its red imperfect Maggot-ſtate; and hence the grains of Cochineal, as brought to us, have rarely any appearance either of feet or wings: If taken whilſt ſome of them are ſtill crawling about, or if the collection is deferred till ſome of them are transformed into winged ſcarabæi, the quality of the Cochineal is debaſed in proportion to ſuch admixture. Some report, that the berries, as they are called, are taken off from the leaves by means of certain inſtruments; but how the ſkins or huſks are ſeparated, we have no account. In the Philoſophical Tranſactions, No 193, it is ſaid, that a ſmoky fire is made on the windward-ſide of the tree; and that the inſects, killed by the ſmoke, fall ſpontaneouſly or are eaſily ſhaken off, upon linen ſheets ſpread underneath, and are afterwards dried in the ſun. Ruieſcher mentions three ways of killing them; one by hot water, which renders them brown on the outſide; another, on hot iron ſhovels, which ſcorch them to a blackiſh hue; and the third in ovens, where they acquire aſh-coloured variegations. Others report, that after they have been killed by the ſteam of hot water, hot aſhes are ſtrewed upon them, and that the white colour is owing to theſe: There is no probability of this; for I have myſelf taken ſeveral of the grains out of their external involucrum or huſk, and found them naturally ſtreaked with white; beſides that this whiteneſs is greater than that of aſhes, and is not to be rubbed off, as aſhes externally adhering would be.

Freſh Cochineal loſes in drying about two thirds of its weight: I have made the experiment with from three to four pounds, which by drying were reduced to ſixteen and eighteen ounces.

Different ſorts. The dried Cochineal is ſorted into large entire grains, and ſmall or broken ones: The firſt are called by the Spaniards *Grana*, the latter *Granilla*. In trade four ſorts are diſtinguiſhed, *Meſteque*, *Campeſchane*, *Tetreſchale*, and *Sylveſter*; of which the firſt is accounted the beſt and the laſt the worſt: The three former are named from the places where they are produced; the latter, from its being found wild, without any culture. The differences in the cultivated Cochineal are very conſiderable, depending partly upon the climate and ſeaſon, partly upon the curation, and partly upon the ſpecies of plant.

The fruit of the Opuntia itſelf is of a red colour, and is ſaid, when eaten, to tinge the urine red: Thoſe ſorts, whoſe fruit is of the deepeſt red colour, are obſerved to produce the fineſt Cochineal. Sir Hans Sloane diſtinguiſhes the beſt ſpecies by the name of *Opuntia maxima, folio oblongo rotundo majore, ſpinulis obtuſis mollibus & innocentibus obſito, flore ſtriis rubris variegato*, the very large Opuntia, with an oblong roundiſh large leaf, beſet with ſoft blunt harmleſs ſpines, and a flower variegated with red ſtreaks. In the Memoirs of the French Academy for the year 1714, another ſpecies is preferred, namely, that called by Tournefort *Opuntia major validiſſimis ſpinis ſive aculeis munita*, the greater Opuntia armed with very ſtrong ſpines or prickles.

The beſt Cochineal is ſomewhat heavy, or at leaſt not very light, moderately compact, clean, dry, of a gloſſy ſurface, of a dark blackiſh red colour on the outſide, with white ſilver-like ſtreaks. Chewed, it tinges the ſpittle of a deep browniſh-red colour, and impreſſes a kind of faint not agreeable taſte. When thoroughly dry, it has no ſmell; when moiſt, a ſomewhat muſty one.

A tinc-

A tincture drawn from powdered Cochineal by digeſtion with water, was very gelatinous: Out of four drams of Cochineal, one dram remained undiſſolved, and the extract obtained by evaporating the liquor weighed three drams. The ſame quantity, digeſted with rectified ſpirit, yielded two drams two ſcruples and a half of extract, or half a ſcruple leſs than with water; the reſiduum being half a ſcruple more. The ſpirit, drawn off by diſtillation, was found to have received no change; the diſtilled water had greateſt part of the muſty ſmell of the inſect. COCHINEAL. Analyſis.

The tincture of Cochineal by itſelf is of a much weaker red colour than when certain ſaline additions are employed: Volatile alcalies in particular not only render the colour deeper and richer, but at the ſame time incline it rather to a purple than to a pure red; whilſt acids brighten, and if their quantity is large, deſtroy it. The ſpirituous tincture is of a finer red than the watery. I have made eighteen other experiments with different ſaline liquors and ſolutions, but as nothing very remarkable was obſerved, I ſhall not relate them here. Colour extracted and improved.

An ounce of Cochineal, diſtilled in an open fire very gradually and cautiouſly increaſed, gave over firſt two ſcruples and three grains of mere phlegm, then four ſcruples of an urinous ſpirit, and fifteen drops of an oily ſpirit, followed by twenty-two grains of volatile Salt, and five ſcruples two grains of empyreumatic Oil: The Caput mortuum weighed two drams two ſcruples, and yielded five grains of a fixt lixivial Salt. Analyſis by fire.

Cochineal has been ſuppoſed to poſſeſs ſome medicinal virtues, but its principal uſe is as a colouring drug. It is with this inſect, that ſeveral of the red tinctures, waters and ſpirits of the ſhops are tinged; that ſcarlets and fiery reds are dyed upon ſilk and woollen; that Spaniſh wool uſed for a fucus, and ſome kinds of the red Turnſol rags, are ſtained; that Carmine, and ſome other fine red lakes, are prepared for the painter. The preparation of Carmine is deſcribed by Homberg in the Hiſtory of the French Academy publiſhed by du Hamel, pag. 345. but the *Chouan* and *Autour*, mentioned there, are now omitted——This drug is extremely rich in colour: Boyle informs us that a ſingle grain, extracted by Spirit of Urine, gave a red tincture to 125000 times its quantity of water (*u*). Uſes.

SECT.

(*u*) *Hiſtory of Cochineal as a dying drug.*] Cochineal, infuſed or boiled in water, imparts a crimſon tincture, inclining to purple. After the more ſoluble parts have been got out by light infuſion or coction, the tinctures extracted from the remainder by ſucceſſive freſh parcels of water, have more and more of a purple hue. Woollen cloth, prepared by boiling with a little Alum and Tartar, acquires a crimſon dye on being boiled with a proper quantity of Cochineal in fine powder.

The beauty of crimſon, as Mr. Hellot obſerves, (from whoſe *Art de teindre*, great part of the remainder of this article is extracted) is to incline as much as poſſible to the gridelin, or to be extremely deep. Fixed alcaline Salts give the deſirable deepneſs, but tarniſh the colour and diminiſh its luſtre. Volatile alcalies have the ſame good effect as the fixed, without their bad one; but the great volatility of theſe Salts occaſions them to be ſo plentifully diſſipated from the hot liquor, that a very large quantity would be neceſſary to effectually anſwer the purpoſe. Mr. Hellot, however, has diſcovered a method of applying them to good advantage: The cloth, dyed crimſon in the uſual manner, is dipt in a ſolution of a little Sal ammoniac; and as ſoon as the liquor grows moderately

Cochineal. moderately warm, a quantity of Pot-aſh, equal to that of the Sal ammoniac, is thrown in: The volatile alcali of the Sal ammoniac is inſtantly extricated, and communicates to the cloth the brilliancy and deepneſs required.

A ſmall quantity of the vitriolic acid, dropt into a decoction of Cochineal, changes it to a purple: On adding more and more of the acid, the liquor becomes fleſh-coloured, and at laſt colourleſs. Spirit of Nitre, in like manner gradually dropt in, firſt inclines the colour to yellow, then turns it quite yellow, and at laſt almoſt deſtroys it; the acid diſſolving or attenuating the colouring particles, ſo as to render them indiſtinguiſhable by the eye.

Solution of Tin in Aqua regis heightens the colour into a ſcarlet, more or leſs fiery, that is blended with more or leſs of a yellow hue, in proportion to the quantity of the ſolution: The liquor, thus heightened, communicates its own ſcarlet colour to woollen cloth prepared by boiling with Tartar.

Other metallic ſolutions have not this effect. Zinc diſſolved in Spirit of Nitre changes the red of Cochineal to a ſlaty violet: Solution of Biſmuth in Spirit of Nitre, diluted with an equal quantity of water, and dropt into a decoction of Cochineal, produced on prepared cloth dipt therein a very beautiful and lively turtle-grey: A ſolution of Copper in Spirit of Nitre, undiluted, gave a dirty crimſon: Solution of cupelled Silver, a ſomewhat tawny Cinnamon colour: Solution of Gold, a kind of marbled cheſnut, the cloth appearing as if compoſed of Wool of different colours: Solution of Mercury in Spirit of Nitre, nearly the ſame: Tincture of Biſmuth-ore in Spirit of Nitre, a purple almoſt violet, as beautiful as if the Cochineal had been applied upon cloth previouſly dyed of a ſky-blue. Vitriolated Tartar deſtroyed the red colour of the Cochineal, and produced a grey, though the ingredients of that Salt, ſeparately, have a different effect.

The dyers are ſaid to prepare their ſolution of Tin for ſcarlet, by pouring upon the metal a quantity of Aqua fortis diluted with water; with the addition ſometimes of a little Nitre, which is ſuppoſed to contribute ſomewhat to the uniformity of the colour. We have formerly ſeen (page 87.) that Aqua fortis does not perfectly diſſolve this metal; and what it does diſſolve at firſt, it ſoon depoſites again, in form of a thick Mucilage; the clear liquor retaining ſcarcely any thing of the metal. The proper menſtruum of Tin is Aqua regia, or a mixture of the nitrous acid either with the marine, or with neutral Salts containing it, as common Salt and Sal ammoniac. If eight ounces of Spirit of Nitre be diluted with an equal quantity of water, and half an ounce of Sal ammoniac and two drams of Nitre diſſolved in the mixture; the menſtruum ſo prepared will diſſolve, and keep diſſolved, about an ounce of Tin, provided the metal be previouſly reduced into grains or ſmall parts, and very leiſurely dropt into the liquor, grain by grain, waiting till one is diſſolved before another is put in. This ſolution depoſites no Mucilage: It becomes indeed opake and milky in the great heats of ſummer, but, in cold weather it reſumes its limpidneſs and tranſparency; and even in its milky ſtate, Mr. Hellot ſays, it is found to anſwer as well in every reſpect for dying ſcarlet as when it is tranſparent; whilſt the ſolutions made in the common manner, when once they have grown thick or opake, which they do in a day or two or leſs, cannot be employed at all for that uſe.

Woollen cloth requires, for being dyed ſcarlet, about one ſixteenth its weight of Cochineal; a part of which is uſed along with the Tartar in the preparatory liquor, from which the cloth receives a lively fleſh-colour; and the reſt for finiſhing the dye; a ſuitable quantity of the ſolution of Tin being added in both decoctions.

The copper veſſels, employed for the dying of other colours that require boiling, are leſs proper for ſcarlet; the acid liquor being apt to diſſolve a part of the Copper, which precipitates a proportionable quantity of the Tin, and deadens the colour and ſtains the cloth. Tin veſſels are commonly made uſe of, and are undoubtedly the moſt ſafe and certain: Their expenſiveneſs however, and the great precaution neceſſary to keep them from melting, have induced ſome of the French dyers to ſearch for means of making the proceſs ſucceed in Copper ones: By keeping the coppers extremely clean, and confining the cloth in a net ſo as not to touch the ſides, they are ſaid to have produced ſcarlets ſcarcely, if at

all

at all inferior to thoſe dyed in Tin veſſels.

The ſcarlet proves darker or of a more fiery orange colour, according as the ſolution of Tin is uſed in ſmaller or larger quantity. Hence too great darkneſs is eaſily remedied by adding more of the ſolution; the cloth being previouſly taken out, and the additional acid mixed thoroughly with the liquor before it is put in again. Scarlet which has too much fire is darkened by paſſing it through warm water; and if the exceſs is greater than this can remedy, by diſſolving in the water a little Alum; but the injury which an over-proportion of the acid ſolution does to the cloth, is irremediable.

Some of the French dyers give fire to their ſcarlets, without any injurious quantity of the acid, by the addition of a yellow drug, Turmeric; but the luſtre which the Turmeric gives, like the dye of Turmeric by itſelf, ſoon periſhes. It is obſervable that the ſcarlet dye is only ſuperficial, the internal part of the cloth being white: When yellow drugs are added, they do not make the ſcarlet ſink, but ſink themſelves through the whole ſubſtance of the cloth, and thus are readily diſcovered upon cutting.

All urinous and alcaline ſubſtances ſtain ſcarlet to a crimſon, by deſtroying the effect of the acid: If ſcarlet cloth be boiled in alcaline Ley, it becomes firſt crimſon, then purpliſh, and on continuing the coction gives out the whole of its colour to the liquor; from which the colouring matter may be precipitated, by adding a ſolution of Alum, into a crimſon lake.----Hence in pure country air, ſcarlet retains its luſtre much longer than in large cities where alcaline and urinous vapours are more abundant. The dirt of roads, and ſundry ſubſtances of the acrid kind, leave no ſtain in ſcarlet, if the part be waſhed immediately with pure water and a white linen cloth. If the dirt is ſuffered to dry, a blackiſh violet ſpot will remain, which can be taken out only by mild vegetable acids, as Vinegar, Citron-juice, a warm dilute ſolution of white Tartar, or ſour bran-water: If theſe acids, however, be not applied with a good deal of addreſs, whilſt they take out the blackiſh ſtain, they leave a yellow one, by diſſolving the colouring particles of the Cochineal itſelf.

It is obſervable, that if a piece of ſcarlet be boiled in the liquor by which cloth is prepared for receiving this dye, it loſes immediately great part of its colour; which, if freſh pieces of white cloth are boiled along with it, will be imbibed by them, and equally diſtributed among them all. After the boiling has been continued about an hour, it will be difficult to diſtinguiſh that which had been ſcarlet from thoſe which were white. COCHINEAL.

After all the common proceſſes of dying with Cochineal, there is found at the bottom of the veſſels a conſiderable quantity of a deep brown-coloured ſediment. This is found, when ſolution of Tin has been uſed in the dye, to contain a calx of Tin, from which the Tin may be recovered, though ſomewhat difficultly, by fuſion with inflammable ſubſtances.

The reſt of the ſediment appears to conſiſt of the impurities of the Tartar, and the groſſer parts of the powdered Cochineal. The lighter animal matter being waſhed off with water, dried, ground on a marble with an equal quantity of cryſtals of Tartar into an impalpable powder, and then put into water with a little Alum; a piece of white cloth, boiled in this liquor for three quarters of an hour, acquired a very beautiful crimſon dye.

This experiment evinces, that by reducing Cochineal into a powder of moderate fineneſs as commonly practiſed, we do not gain all the advantage, which this valuable commodity is capable of yielding. If the Cochineal, after the uſual pulverization, be mixed with one fourth its weight of pure dry cryſtals of Tartar, and the mixture levigated into a powder really impalpable; the ſaving, in the Cochineal, whether for the crimſon or the ſcarlet dye, will be, according to Mr. Hellot, about one part in four. Though no Tartar is uſually employed in the red or dying liquor, the quantity here directed does no injury; it appeared on trial, that the colour was rather the more ſolid for it. In the preparatory liquor, the quantity of Tartar may be diminiſhed proportionably to that contained in the powder.

The wild Cochineal or Sylveſter is greatly inferior to the fine ſort called ſimply Cochineal: Four parts of the former have no greater effect in dying than one of the latter.

KERMES. ter. Nor does the Sylveſter anſwer, in general, ſo well as the other in regard to the beauty of the colour, particularly for ſcarlet.

VI. KERMES.

KErmes grains, ſo called, are roundiſh bodies about the ſize and ſhape of a pea, containing under a firm reddiſh-brown ſkin, a great number of ſmall particles of a deeper red colour; found adhering in the ſouthern parts of Europe, to the branches and leaves of the ſcarlet Oak, *ilex aculeata coccigiandifera C. B.* A ſmall inſect, leſs than a Millet ſeed, fixes itſelf upon the tree in the beginning of March, and is by degrees diſtended into this form: The body of the inſect becomes the huſk or nidus, and the red particles are its eggs.

The Kermes grains are cured for exportation, by drying them on linen cloths; ſome ſtrong Vinegar being previouſly ſprinkled upon them, to prevent the excluſion of the eggs, or kill ſuch of the inſects as may be already hatched. In drying, the eggs and young animalcules fall into a red powder, which in ſome places, particularly in Spain, is ſeparated from the huſks by a ſieve: The huſks are then formed into balls, and a proportionable quantity of the powder put into the middle of each.

Freſh Kermes yields upon expreſſion a red juice, of a light pleaſant ſmell, and a bitteriſh, roughiſh, ſomewhat pungent taſte: This, made into a ſyrup with Sugar, is brought from the South of France for medicinal uſe, and held to be mildly reſtringent and corroborant.

The dry grains impart the ſame ſmell and taſte, and a deep red colour, both to watery and ſpirituous liquors: Both tinctures retain their colour on being inſpiſſated to the conſiſtence of extracts; nor do they loſe any thing conſiderable of their taſte, but the watery loſes all its ſmell.

Woollen cloth, prepared with Alum and Tartar, acquires, on being boiled with dry Kermes berries, a durable deep red colour, called *ſcarlet in grain* from the Kermes having been formerly ſuppoſed to be the grain or ſeed of the tree, and *Venice ſcarlet* from the greateſt quantities having been dyed there. This colour wants the luſtre and fire of the Cochineal ſcarlet now in vogue, but in return is far more permanent, not ſubject to be ſtained by dirt or acrid liquors, and when ſpotted with greaſe may be cleaned again without injury to the colour.

Mr. Hellot obſerves, that the figured cloths to be ſeen in the old tapiſtries of Bruſſels and the other manufactures of Flanders, which have ſcarce loſt any thing of their livelineſs in ſtanding for two hundred years, were all died with this ingredient: That nevertheleſs Kermes is at preſent entirely in diſuſe among the European dyers, though ſaid to be commonly employed in the Levant, and exported thither from Marſeilles in conſiderable quantities: That when the Kermes ſcarlet (now called an ox-blood colour) is wanted for tapiſtries, *&c.* our dyers endeavour to imitate it with Cochineal; that as the colour is difficultly hit with Cochineal alone, they generally add a portion of Brazil-wood; and that the dyes thus produced, though at firſt more vivid than they ought to be, often loſe their luſtre before a year is at an end, and turn white and grey in an extraordinary manner: That Kermes might be again introduced to very good advantage, as its colour is of the moſt durable kind, and as ſundry ſhades are obtainable from it with leſs trouble and expence than from other drugs.

The ſame author has given a great number of experiments upon Kermes, with different Salts and metallic ſolutions. The principal of theſe are as follows.

On adding to decoction of Kermes a ſmall quantity of ſolution of Tin, the dark colour of the liquor is immediately brightened, and prepared woollen dyed therein inclines more to the orange than with the Kermes alone. With this improvement of the colour, it receives the imperfections, though not all the beauty of the Cochineal ſcarlet; all alcaleſcent ſubſtances ſtaining the cloth, that is deſtroying the effect of the acid ſolution.

Kermes with Creme of Tartar and as much of the ſolution of Tin as is employed for the Cochineal ſcarlet, (without any Alum,) dyed unprepared cloth of an extremely vivid Cinnamon colour. On dipping the cloth in a ſolution of Alum, a part of the red reappeared, but was not beautiful.

With Creme of Tartar, ſolution of Tin, and Alum in larger quantity than the Tartar, this drug gives purpliſh colours, which vary

vary according to the proportions of the ingredients.

If vitriolated Tartar be ſubſtituted to the Alum and Tartar; and if after the Kermes has been boiled in a ſolution of a ſmall quantity of this Salt, the ſtuff be boiled in this mixture for about an hour, the dye proves a beautiful kind of grey, in which the red is little perceived.

Glaubers Salt employed along with Kermes entirely deſtroys its redneſs, and gives an earthy grey colour. This dye is very periſhable, on account of the particular nature of the ſaline ſubſtance by means of which the tinging particles are applied; for Glaubers Salt diſſolves eaſily in cold water, and falls into a powder in the ſun's heat. This obtains equally in all dyes; thoſe drugs which afford moſt durable colours with Tartar and vitriolated Tartar, give very periſhable ones with the more diſſoluble and calcinable Salts.

Green and blue Vitriol, ſubſtituted ſeparately to Alum, but taken in conjunction with Creme of Tartar, deſtroy likewiſe, or conceal the red colour of Kermes, which in theſe two experiments has the ſame effect with Galls, for it precipitates the Iron of the green Vitriol which tinges the cloth of a bright grey, and the Copper of the blue which gives a kind of olive dye. It likewiſe gave an olive dye with ſolution of Copper made in Aqua fortis; a certain mark, that it poſſeſſes, like Galls, an aſtringent precipitating quality. It is probably the aſtringency of Kermes that renders its dye ſo durable; for all the barks, woods, roots and other ſubſtances that are aſtringent, yield permanent colours.

White Vitriol, employed with cryſtals of Tartar, changes the red colour of Kermes into a violet. A tincture of Biſmuth-ore in Spirit of Nitre, and a ſolution of Biſmuth itſelf made leiſurely in four times its weight of Spirit of Nitre diluted with an equal quantity of water, gave alſo a violet dye upon white cloth.

VII. COCCUS POLONICUS.

COccus Polonicus is the egg of an inſect, about the ſize of a Coriander ſeed, of a purple-brown colour on the outſide and full of a blood-red juice; found adhering to the upper part of the roots of a ſpecies of Knotgraſs called *Polygonum cocciferum*, Polonian knawel. It is met with in great abundance in waſte ſandy grounds in different parts of Poland, particularly in the Ukrain. Coccus.

According to Bernhardus a Bernitz (in the *Ephemerides naturæ curioſorum. dec.* 1. *an.* 3.) the peaſants take up the plant about midſummer, by means of a ſmall concave ſpade or dibble, and having picked off the berries as they are called, replace it in the ground, with ſurprizing celerity and addreſs. The Coccus, cleaned from the earth by ſifting, is dried in a warm room or by the ſun's heat; ſome Vinegar or very cold water being ſprinkled on, to prevent the excluſion of the inſects. Sometimes the red matter is ſeparated from the ſkins and formed into balls by gentle preſſure, ſo as not to ſhed or waſte the colouring juice.

The ſame author relates, that the Turks and Armenians, who purchaſe the Coccus from the Jews in Germany, employ it for ſtaining wool, hair, leather, and the manes and tails of their horſes, red: That the juice mixed and extracted with Citron or Pomegranate-juice, or with Wine, is in daily uſe among the Turkiſh ladies, for ſtaining the ends of their fingers and toes: That formerly the Dutch dyers mixed their Cochineal with one half of Coccus Polonicus both for ſcarlets and for crimſons: That a tincture of the Coccus extracted with Citron-juice, or a certain Lixivium, with Alum and a little Gum arabic, was uſed by the painters, particularly in Ruſſia: That with whiting it yields a crimſon lake equal to that prepared from Cochineal or ſcarlet cloth: That he ſaw an excellent Carmine made from it by a particular perſon at Paris, which was ſold for three guineas (*tribus aureis*) a dram: And that the red Spaniſh paper and wool, ſo much in uſe at the toilettes of the French and Spaniſh ladies, receive their colour from the juice of this drug.

The trade in this commodity has nevertheleſs been for a long time very inconſiderable: Among us, the Coccus is at preſent ſcarcely otherwiſe known than by name. Mr. Hellot informs us, that having procured ſome from Dantzick, for trial as a dying drug, it came dearer than Cochineal, as it did not afford one fifth ſo much colour as that American inſect does; and that he never could by any means obtain from it a

ſcarlet

Coccus. scarlet dye, nor any other than *lilas*, flesh-colours and crimsons, more or less lively. Mr. Marggraf observes, in the Berlin Memoirs, that this insect contains, like Ants, an expressible Oil; that this principle is the cause of the failure of those who have employed it in dying; and that means may be found of preventing the ill effects of the oily matter. For my own part, I have had no experience of it.

VIII. PURPLE FISH.

THE precious Tyrian purple of the ancients was procured from a shell-fish of the *Buccinum* or Whilk kind: A small vein found in the body of the animal, though colourless itself, communicated the admired dye.

Towards the end of the last century, the same sort of fish was discovered in plenty on some of the shores of Ireland, on those of Somersetshire, and the opposite ones of South Wales; and some persons made considerable profit by marking linen with its juice, of a fine durable crimson colour.

The shell, which is considerably hard, is broke by a smart blow, with care not to crush the body of the fish within. After picking off the broken pieces, there appears a white vein or reservoir, lying transversely in a little furrow near the head. This being carefully taken out, and characters drawn with it, or its viscid juice squeezed, upon linen or silk, the part acquires immediately on being exposed to the sun, a pale yellowish-green, which quickly deepens into an emerald green, then changes to a blue, and at last to a fine purplish red. If the cloth be now washed with scalding water and Sope, and laid again in the sun, the colour changes to a beautiful crimson, which suffers no further alteration from sun or air, or Sope, or Alum, or alcaline Leys, or any of the substances used for essaying the permanency of colours.

The juice of the Purple Fish receives no colour itself, and communicates none to silk or linen, without exposure to the sun. It seems to be the light, and not the heat of the sun, that calls forth the tincture; for when the cloth is covered with thin opake bodies, which transmit heat without light, no colour is produced, while transparent ones give no impediment to its production. The juice itself, in close glass vessels, becomes presently purple in the sun. The light of culinary fire, concentrated by convex glasses and concave mirrors, has no effect. The succession of colours is best observed when the sun is low and his action weak: at noon in summer they are so quick as not to be easily distinguished. See the Philosophical Transactions, N° 178, and the Memoirs of the French Academy for the year 1736, and 1711.

Mr. Reaumur informs us, in the Memoirs for the year last mentioned, that on some of the French coasts he found great numbers of small elliptical spheroidal bodies adhering to the rocks by a short stem like fruits, and that the purple fishes were commonly accumulated plentifully about these. On examining these bodies, he found them to be vesicles filled with a liquid of the same quality with the juice of the fish, but less viscid, and of consequence more readily spreading upon the linen. He suspects them to be the eggs of some sea fish, perhaps of the Purple Fish itself, though he never could observe any thing like them on dissecting that fish, nor any animal produced from the vesicles. He says they are in perfection only in autumn; and that when any are met with in summer, they have either lost their colouring juice, or the juice has lost its power of becoming purple in the sun.

SECT.

SECT. IV.

HORNY PARTS *of* ANIMALS.

HORNS.

BY horny parts we underſtand thoſe, which are dry and hard, in ſome degree flexible, very conſiderably ſo when heated, and ſo coheſive as not to be at all pulverable in a mortar; whether produced upon the forehead, or on the feet of animals. The general name of the claſs might be taken indeed with greater propriety from the productions of the feet; for the hoofs and claws and nails of all animals are of this kind, but ſome horns are not. The horns of the Rhinoceros and the Ox are of the truly horny kind, but thoſe of Hart are of the bony.

I. RHINOCEROS'S HORN.

THE RHINOCEROS is ſo called from ῥὶν a noſe, and κέρας a horn; the horn or horns being placed, not where thoſe of other animals are, but immediately above the noſe, betwixt the eyes. The Rhinoceros is a very large, fierce quadruped of prey; an inhabitant of woods and deſarts in different parts of Aſia and Africa. He has very little hair, but the ſkin is remarkably tough and ſtrong, above half an inch thick, and full of wrinkles, ſo as to look, when he moves, like ſcales. He is ſwift of foot, though the legs are ſhort; and of an extraordinary quick ſcent: The ſight is weak, and the eyes deep; ſo that he cannot ſee ſidewiſe, nor turn quick. The figures of this animal, given by natural hiſtorians differ from one another: The ſkin, preſerved in the Muſæum of the Royal Society of London, comes the neareſt to thoſe of Bontius and Piſo.

This animal has been generally ſuppoſed to have only one horn, but appears to have often two, a large and a ſmall one; of which there are ſpecimens in many collections in Europe, particularly in that of his Daniſh majeſty. The horn is at firſt white; by age it grows grey, and at length blackiſh on the outſide, its internal whiteneſs continuing: Its length is from a quarter of an ell to an ell, according to the age of the animal: It is always ſomewhat crooked, remarkably thick at the bottom, and not equably taper or of a regular pyramidal figure, but drawn in ſlender a good way below the tip: It is ſolid throughout, except a little hollowneſs at the baſis, where it is alſo externally rough, chapt, full of ſmall holes, and beſet with ſtiff hairs, of which in the horns brought to us, only the roots generally remain: The upper part is ſmooth. Its texture is very compact; and in thin pieces it has ſome degree of tranſparency. It is uſed for ſundry mechanic purpoſes, as for making ſword-hilts, knife-handles, cane-heads, ſnuff-boxes and other toys. It was formerly of great eſteem for drinking veſſels, from an idle notion of its reſiſting poiſon.

Half an ounce of Rhinoceros's horn, finely raſped, gave with rectified Spirit of Wine only four grains of extract, which had a rancid taſte, without any

RHINOCEROS'S HORN.

ſmell: The remaining horn looked reddiſh. The ſame quantity, boiled ſtrongly with water, yielded two ſcruples of gelatinous extract, of a brown colour, and ſomewhat ſaline taſte: The reſiduum was grey. The mineral acid ſpirits, and cauſtic alcaline Lixivia, almoſt totally diſſolve it: The ſolutions made in the nitrous and vitriolic acids are yellow; in the marine, colourleſs. Weaker ſaline menſtrua, as Oil of Tartar per deliquium, Spirit of Sal ammoniac, and the vegetable acids, have no effect on it. We may judge from hence, that this horn can have no great claim to any medicinal virtue, as it is not diſſoluble in the fluids of animal bodies.

Two ounces of the raſped horns, diſtilled in a retort with an open fire, yielded half an ounce and a ſcruple of urinous liquor, two drams of fetid Oil, and three drams and a ſcruple of volatile alcaline Salt: The Caput mortuum, which weighed ſix drams, afforded a ſmall portion of fixed lixivial Salt. The phlegm which aroſe at firſt, amounting to about two drams and a ſcruple, was conſiderably fetid, and had ſomewhat of a volatile ſmell.

There are ſome other animals which have received the name of Rhinoceros, from their being furniſhed with a horn ſituated nearly in the ſame manner. One is the *ſcarabæus cornutus* or horned chafer, found about tan-pits and where leather is buried in the ground. Another is the Rhinoceros bird, or horned Indian Crow: Its beak, and the upper part of the horn, is red like minium, the middle yellow, and the margin ſtreaked with black: An entire head is preſerved in the Muſæum of the Royal Society. Willoughby and others mention alſo an Indian horned fiſh.

II. OX-HORN.

THE horns of OXEN and Cows are leſs compact than thoſe of the Rhinoceros, but more tranſparent. They are uſed for tobacco and ſnuff-boxes, for powder-horns, the horns of lanthorns, imitations of tortoiſeſhell, *&c.* as alſo for hardening Iron by cementation, *&c.*

Half an ounce of theſe horns, digeſted with rectified Spirit of Wine, gave five grains of extract, or one grain more than I had obtained from an equal quantity of the Rhinoceros's horn. Boiled in water, they yielded leſs extract than the horn of that animal; only five and twenty grains being obtained from half an ounce, whilſt the ſame quantity of the other gave forty grains. The watery extract was of a yellowiſh-brown colour and ſaline taſte, and the reſiduum grey: The ſpirituous extract was the ſame with that of the Rhinoceros's horn, but the remainder had acquired no redneſs or change of colour.

Spirit of Nitre diſſolves theſe horns totally. Spirit of Salt diſſolves them only in part; the ſolution is of a reddiſh-yellow colour. Spirit of Vitriol alſo only partially diſſolves and corrodes them, acquiring a ſlight yellow tinge. Spirit of Sal ammoniac and Oil of Tartar extract exceeding little: The liquors, however, become yellowiſh, and the horn brown. Cauſtic alcaline Lixivia totally diſſolve the horn into a yellow liquor.

Sixteen ounces of Cows-horn, diſtilled in an open fire, gave over in all nine ounces and a half of mixed matter: Of volatile Salt I had two ounces three drams; of urinous ſpirit five ounces and a half; and of empyreumatic Oil one ounce five drams; the Caput mortuum weighed five ounces and a half; and in calcination to whiteneſs loſt an ounce: From the white calx I extracted, by elixation with water, ſix grains of a fixed ſaline matter.

In

In another distillation of Cow's-horn, I obtained, from two ounces of the horn, half an ounce and half a dram of urinous liquor, a dram and a half of fetid Oil, and three drams and a half of volatile Salt (*x*): The Caput mortuum weighed six drams and a half, which probably would not have yielded a single grain of fixed Salt, as in the foregoing experiment I had obtained but six grains of that Salt from sixteen ounces of the horns. OX-HORN.

III. TORTOISE-SHELL.

THE beautiful shell of the TORTOISE belongs also to this class. The Tortoise is an oviparous four-footed animal, whose body is inclosed in two shells joined together along the sides, into which it can likewise occasionally draw in both the feet and the head: The upper shell is convex, the lower flat. There are many different kinds of Tortoises in America and the East-Indies, some living almost wholly on the land, others almost wholly in water, and others equally in both; some of an oval and others of an angular figure; of various colours on the upper shell, as yellow, black, brown, white, purple, greenish, with different clouds and variegations; some small, weighing a few pounds, and others of enormous sizes.

The upper shell of the Tortoise is composed of two dissimilar substances: That which immediately invests the back of the animal is of the bony kind, and almost as hard as stone: The outer lamina is horny, flexible, here and there transparent. It is only this last that is called Tortoise-shell, and in which the beautiful colours and variegations reside. The horny shell consists of several pieces, whose seams and junctures with one another, and with the bony part underneath, are sufficiently distinguishable. The workmen split them asunder by certain instruments, and employ the elegant horn for a variety of toys and utensils, combs, sword-hilts, clock-cases, boxes, coverings for musical instruments, perspective-glasses, *&c. &c.* I have often been surprized at their dexterity in working and polishing this shell, but particularly at the neat manner in which they unite two pieces together, the union being so curiously performed, that it is scarce possible to distinguish the juncture. They have likewise methods of embellishing it with sundry beautiful colours, besides those which it receives from nature (*y*).

Half

(*x*) *Volatile Salt.*] The proportion of volatile Salt in these two experiments is considerably different, being in one *two ounces three drams*, and in the other *three ounces four drams*, from sixteen ounces of the horn. Whether this has happened through any mistake, or from different pieces of horn affording quantities of Salt really so different, or from more of the Salt having been dissolved by the spirit in one experiment than in the other, I cannot determine. Perhaps, as the two analyses appear to have been made at distant times, and with somewhat different views; in the former the *purified Salt*, and in the latter the *rough Salt* may be meant.

(*y*) *Working and joining of Tortoise-shell.*] Tortoise-shell and horn become soft in a moderate heat, as that of boiling water, so as to be pressed, in a mould, into any form, the shell or horn being previously cut into plates of a proper size.

Plumier informs us, in his *Art de tourner*, that two plates are likewise united into one by heating and pressing them; the edges being thoroughly cleaned, and made to fit close to one another. The Tortoise-shell is conveniently heated for this purpose by applying a hot iron above and beneath the juncture, with the interposition of a wet cloth to prevent the shell from being scorched by the irons: These irons should be

TORTOISE-SHELL. Half an ounce of Tortoiſe-ſhell, digeſted with Spirit of Wine, yielded four grains of extract, which ſmelt like the newly diſtilled water of Cow-dung (*Aqua omnium florum*) and taſted ſomewhat ſaline. Another half ounce, boiled in water, gave fifteen grains of extract, of a brown colour and ſaline taſte. The ſhell remaining after the action of both menſtrua, was in appearance unchanged.

Spirit of Vitriol diſſolves greateſt part of it into a reddiſh-brown liquor: Spirit of Nitre and Spirit of Salt diſſolve the whole; both theſe ſolutions are ſomewhat yellowiſh. Spirit of Sal ammoniac corrodes it a little, but receives no colour. Fixt alcaline Lixivia likewiſe corrode a little of the ſhell, and acquire a yellowiſh tinge: Cauſtic alcalies corrode more of it, and become yellower.

Two ounces of Tortoiſe-ſhell, diſtilled in an open fire, yielded a dram and a half of phlegm, of an urinous ſmell; a dram and a half of a pretty fetid urinous ſpirit; half an ounce of empyreumatic Oil, which ſmelt likewiſe very volatile, but leſs fetid than the ſpirit; and three drams and a half of volatile Salt extremely fetid. The Caput mortuum weighed five drams and a half.

IV. ELKS-HOOF. AS the hoof of the ELK has been celebrated for ſome extraordinary qualities, it was thought proper to examine it chemically, and compare it with that of the ox.

The Elk is a wild quadruped, of the Stag kind, but ſomewhat larger, extremely fearful of men, an inhabitant of woods in the cold countries, as Poland, Ruſſia, Lithuania, Courland, Sweden, Norway, Ruſſia, *&c.* It is a great rarity if any of them ſtrays into Sileſia, Pomerania, Hungary or our neighbourhood [Berlin.] Moſt of us however have ſeen the animal, as his majeſty has often had young ones brought from Pruſſia. The male ſheds his horns annually like the common Stag, but the female has no horns. The fleſh is ſaid to be equal to veniſon.

The ſkin of this animal is one of the thickeſt, ſtrongeſt, and fineſt kind of leather in the world. The bones are ſaid to be not inferior to ivory, and to have one advantage above it, that they are not ſo apt to turn yellow. The hoof is made into boxes, bracelets, rings and other toys.

The hoof of the Elk is commonly ſomewhat longer and larger than that of the Stag, of a black colour on the outſide and whitiſh within. The outer part is very compact, firm and horny; the inner white part is tranſparent; and within this is another whitiſh ſubſtance. On each foot there are two large cloven hoofs, and above theſe two ſmaller ones.

It is ſaid that the Elk is ſubject to epileptic fits; and that he effectually cures them by ſcratching behind his right ear with his left hinder hoof, or behind his left ear with the hinder hoof of the right ſide; for the hoof of the ſame ſide, or the hoof of the fore foot will not do: From hence Elk's-hoof has been celebrated as a ſpecific in epilepſies, being taken internally, or worn as an amulet. If one could be ſerious on ſuch a ridiculous occaſion, we might aſk, how it comes

pretty thick, that they may not loſe their heat before the union is effected.

Both Tortoiſe-ſhell and horns may be ſtained of a variety of colours, by means of the colouring drugs commonly uſed in dying, and by certain metallic ſolutions. See the article *Bones* in the following ſection.

comes that the Elk ſhould ever be troubled with an epilepſy, when he carries the Amulet conſtantly about him: Whether a man will be affected in the ſame manner by ſwallowing a piece of the hoof in powder, as the animal was by ſcratching himſelf with it: Whether it is anywiſe poſſible for the Elk to get his hinder hoof up to his ears; and if it was, whether the ſcratching might not be more rationally attributed to another cauſe. According to ſome accounts, a kind of ſtinging fly attacks and lodges in his head, and occaſions ſuch uneaſineſs, as might very well warrant his ſcratching himſelf, without any thing epileptic in the caſe. ELK'S-HOOF.

Half an ounce of raſped Elk's-hoof, digeſted with rectified Spirit of Wine, gave ſix grains of extract, which had no remarkable ſmell or taſte: The reſiduum looked reddiſh. Water extracted from the ſame quantity two ſcruples: The inſpiſſated extract had a ſaline taſte, but no ſmell: The reſiduum looked greeniſh.

Spirit of Vitriol partly diſſolved and partly corroded it: Of the corroded matter, part ſwum on the ſurface, and part ſunk to the bottom: The ſolution was reddiſh-brown. Spirit of Nitre totally diſſolved it into a Citron yellow liquor. Spirit of Salt partly diſſolved and partly corroded it, and acquired a richer yellow tincture. Spirit of Sal ammoniac had no effect: Solution of fixt Alcali extracted a ſlight yellowiſh tinge: Solution of cauſtic Alcali totally diſſolved it, and became likewiſe yellowiſh.

On diſtilling two ounces of Elk's-hoof in an open fire, I obtained firſt two drams of a phlegmatic liquor which ſmelt like Sope; afterwards a dram and a half of a ſtinking ſpirit, three drams of empyreumatic Oil, and half an ounce of volatile Salt. The Caput mortuum weighed five drams and a half.

V.

THE hoofs of OXEN and Cows differ very little from that of the Elk, and have commonly been ſubſtituted to it in the ſhops. It is ſaid that Ox's-hoof ſtinks in raſping, whilſt that of the Elk emits an agreeable ſmell. On trial, the ſmell of both was found to be diſagreeable: That of the Cow's-hoof was moſt ſo, not however from any peculiar quality of the hoof itſelf, but from the dung and urine in which this kind of cattle ſo often ſtands. When the hoofs of Cows or Oxen are thoroughly cleaned, their ſmell does not prove remarkably different from that of the Elk's. OX-HOOF.

From half an ounce of raſped Ox's-hoof I obtained ſix grains of ſpirituous; and from the ſame quantity, half a dram of watery extract. The reſidua were of the ſame colour as thoſe of the Elk's-hoof; but there was this difference in the ſpirituous extract, that it ſmelt and taſted a little like Cow-dung. Spirit of Vitriol partly diſſolved and partly corroded Ox's-hoof, in the ſame manner as the Elks, but the ſolution was more of a browniſh colour. Spirit of Nitre diſſolved this equally with the other: The ſolution had leſs of the Citron hue. Spirit of Salt, which partially diſſolved the Elk's, almoſt totally diſſolved the Ox's-hoof into an orange-yellow liquor. Spirit of Sal ammoniac, and ſolution of fixed alcaline Salt, extracted a ſlight yellowiſh tinge: Solution of cauſtic Alcali almoſt totally diſſolved it into a yellowiſh liquor.

Two ounces of raſped Ox-hoof, diſtilled in an open fire, gave over four drams and a half of urinous ſpirit, which ſmelt ſomewhat like Aſa fetida; one

Ox-hoof. dram and a half of empyreumatic Oil; and half an ounce of volatile Salt: The Caput mortuum weighed ſix drams. The Oil and Salt had the uſual empyreumatic ſmell.

In another diſtillation of Ox-hoof, I obtained from ſixteen ounces of the hoof, ſeven ounces ſix drams of urinous ſpirit, one ounce two drams of volatile Salt, and two ounces of empyreumatic Oil. The Caput mortuum weighed three ounces, and was reduced by calcination to two ounces two drams, which yielded on elixation with water twelve grains of a fixed ſaline matter.

VI. Whale-bone.

THE flexible horny ſubſtance, called WHALE-BONE, arms the gums of the common Whale, in the room of teeth. In the mouth of one Whale there are five hundred pieces of this bone, ſome of which are five or ſix ells in length.

Two ounces of Whale-bone, boiled with water, yielded four ſcruples of extract; and afterwards with rectified ſpirit, half a dram: On inverting the order of applying the two menſtrua, I got from the ſame quantity, one dram and four grains of ſpirituous, and afterwards a dram of watery extract. The indiſſoluble part weighed in the firſt caſe one ounce ſix drams eight grains, in the latter one ounce ſix drams thirty grains.

On diſtilling ſixteen ounces of Whale-bone in an open fire, there aroſe five ounces of urinous ſpirit, two ounces of empyreumatic Oil, and a volatile Salt, which when rectified weighed ten drams. The Caput mortuum weighed five ounces, and on being burnt in open veſſels to whiteneſs loſt juſt one half: From the aſhes were extracted, by means of water, fifteen grains of ſaline matter.

SECT. V.

BONY PARTS *of* ANIMALS.

Bones.

BONY ſubſtances are the hardeſt and firmeſt of all the parts of animals; more or leſs brittle; either not at all, or in a very ſmall degree flexible, and not capable of being ſoftened by heat like horn, ſo as to receive figures or impreſſions. Under this head are comprehended not only bones ſtrictly ſo called, but ſome kinds of horns and other animal productions: The horns of the Hart and the Elk are, chemically conſidered, of the bony kind, whilſt the bones of many ſorts of fiſhes, particularly of ſmall ones, are horny or cartilaginous.

Clean ſound bones are white, and of a cloſe compact texture: Such as are diſeaſed, look yellow, browniſh or blackiſh, and porous or corroded: I have ſeen, in England, the ſkeleton of a perſon who died in the laſt ſtage of the venereal diſeaſe, whoſe bones were all carious and corroded, not a ſingle one in the whole body being ſound. It is matter of common obſervation, that Sugar,

too

too hot and too cold liquors, ſmoking Tobacco, &c. make the teeth yellow, black, and carious. Two proceſſes are deſcribed in the *Acta Hoffnienſia* for whitening bones: Profeſſor Rau had a method of giving them a great degree of whiteneſs. By bare expoſure to the air, ſun, and rain, for a length of time, they become notably white; but the whiteſt bones, kept in rooms tainted with ſmoke or fuliginous vapours, grow in a little time yellowiſh, browniſh, and unſightly. It is cuſtomary for the purification of bones, to boil them in alcaline liquors; which by diſſolving and extracting the ſuperfluous fat, improve their whiteneſs. BONES. Whitened.

Boerhaave obſerves, that alcaline Salts render bones harder and firmer; and that acids make them ſofter and more flexible (z). Theſe effects ſucceed in certain circumſtances, but not univerſally; for bones may be hardened and ſoftened both by acids and by alcalies, according to the quantity of the ſaline matter employed, and the manner in which it is applied. I have made bones harder and more compact, by treating them with the ſtrongeſt of the mineral acids; though, when the acid is in ſufficient proportion, it deſtroys or diſſolves them. In Papin's digeſtor (a ſtrong cloſe veſſel, in which the ſteam of boiling liquors is confined, and the fluid by this means made to undergo a greater degree of heat than it could otherwiſe ſuſtain,) the hardeſt bones are reduced, in a ſhort time, by the action of ſimple water, into a ſoft pap or gelly; and alcaline liquors produce this effect ſtill ſooner. Hardened and ſoftened.

In open veſſels, entire bones are difficultly, if at all, to be boiled ſoft by water; but ſuch as are raſped, or otherwiſe reduced into ſmall parts, give out to that menſtruum greateſt ſhare of their oily, gelatinous and ſaline matter. What remains is almoſt a mere alcaline earth: Urged with an open fire, it diſcovers but a ſlight fetid ſmell; and in mixture with Nitre, it occaſions very little deflagration. Raſped bones in ſubſtance, mixed with Nitre and injected into a red-hot crucible, deflagrate ſtrongly, and are very quickly calcined and reduced into a pure white earth. Calcined.

Large entire bones are difficultly calcined to whiteneſs throughout, a part in the middle remaining black and coaly, unleſs the fire is very ſtrong and long continued.

(z) *Bones ſoftened by acids.*] In the hiſtory of the French Academy for the years 1742 and 1743, there is an account that Mr. Geoffroy produced before the Academy a ſmall ivory ſpoon, which by lying long in Muſtard was become flexible and tranſparent like horn: That Mr. Fouchy ſaw an ivory ſpoon, which by lying for a conſiderable time in Milk was become ſupple like Leather; and that Mr. Hunauld produced bones which had been ſoftened by ſteeping in Vinegar, afterwards hardened to their natural ſtate by ſteeping in water, and ſoftened a ſecond time by Vinegar.

I have obſerved that the nitrous and marine acids diluted, and the acetous acid, make bones flexible and tough like leather; but that the diluted vitriolic acid, though it renders them notably ſoft, makes them at the ſame time brittle. It ſeems as if great part of the earthy matter, which is the baſis of the bone and on which its hardneſs depends, was diſſolved and extracted by the three firſt, whilſt the latter, incapable of diſſolving this kind of earth into a liquid form, only corrodes it into a kind of ſelenitic concrete (See page 494.) which remains intermixed in minute particles among the gelatinous matter.

I have not found that the ſoftened bones, whatever acid they were ſoftened by, recovered their hardneſs by ſteeping in water. Slips of ſoftened Ivory, after lying above a month in water, continued nearly as ſoft as when they were taken out of the acid liquor.

BONES. continued. It is obſervable, that ſimple calcination does not reduce bones, as it does vegetable ſubſtances, to aſhes; the bone ſtill retains its original figure, but becomes brittle and crumbly. Boerhaave reports, that bones thus rendered brittle recover their priſtine hardneſs on being ſoaked in water; but on trial, this did not happen: And indeed I could not expect that it ſhould happen, as the bone loſes in calcination its conglutinating, oily, and ſaline parts, which ſimple water cannot poſſibly reſtore to it.

Their uſes. Bones are a very uſeful article, not only for making different kinds of toys, but likewiſe in ſeveral of the chemical arts; as for making caſt Iron malleable (See page 76.); for abſorbing the Sulphur of ſulphureous ores; for forming teſts and cupels, or veſſels for refining Gold and Silver with Lead, burnt bones compoſing a maſs of a porous texture, which abſorbs the vitrified Lead and other metals, whilſt the unvitreſcible Gold and Silver remain entire behind; for the preparation of milky glaſſes and porcelanes; for the rectification of volatile Salts, and empyreumatic Oils; and for making Glue. The bones of different animals are not equally fit for different uſes: Even the Glue or gelatinous part of the bones of one animal is notably different, both in quantity and coheſiveneſs, from that of another, as we ſhall ſee hereafter.

Artificial Turcois. We often find in the earth petrified bones, greateſt part of their gelatinous matter being extracted by the moiſture, and a ſtony one introduced in its room. In ſome parts of France, petrified bones are met with, which have an impregnation of Copper: Hence on being calcined a little in an open fire, a volatile Salt is produced from the remains of their gelatinous principle, and the bone is tinged throughout of a fine greeniſh-blue colour, Copper always ſtriking a blue with volatile alcalies. The French Turquoiſe ſtones are no other than theſe bones prepared by calcination: They are very durable, and bear to be worked and poliſhed nearly in the ſame manner as Glaſs; without the imperfection, inſeparable from glaſſy bodies, of being brittle (*a*).

We

(*a*) *French Turcoiſes.*] Mr. de Reaumur has given a paper on this ſubject in the Memoirs of the French Academy for the year 1715. He informs us that the mines which afford Turcoiſes are chiefly in the lower Languedoc, near the village Simore: That the ſtones, as taken out of the mine, reſemble different bones, teeth, *&c.* of various ſizes, and are in colour whitiſh, grey, or yellowiſh, like the ſtones commonly uſed in building: That they receive their blue colour on being ſlowly heated to ignition; and that if the fire is continued after they have acquired the colour, they loſe it irrecoverably: That the colour, when in perfection, is an opake blue, inclining to green, but without any ſenſible admixture of that colour; and that he has ſeen ſome of them equal in hardneſs as well as colour to thoſe of Perſia: That the beſt are ſcarcely ſo hard as Cryſtal, and that they have a peculiar imperfection of changing, on being long kept, to various ſhades of green, whilſt the colours of other precious ſtones are unalterable: That the methods directed by authors for reſtoring their beauty do not perfectly ſucceed; a Perſian Turcois, which had become green, being ſteeped in Aqua fortis for twenty-four hours, the green colour diſappeared indeed, but the blue which the ſtone acquired was ſo faint that it was not of more value than when it was green: And that the French Turcois is totally diſſolved by Aqua fortis, and gives out its colour to diſtilled Vinegar . . . . This diſſolubility of the French Turcoiſes in acids which have no action on the oriental, ſhews that the baſis of the one is a different kind of earth from that of the other, and affords a ready method of diſtinguiſhing the two.

Colouring

BONES.

We ſhall now proceed to examine, more particularly, the bony ſubſtances of different animals. And here it may be proper to obſerve, that as a thorough knowledge of the chemical ſtructure and principles of the different ſubſtances ranked together in one general diviſion, as horns or bones, can be obtained only from an actual examination of a number of the particular ſubſtances belonging to each diviſion; I have choſen, for the ſubjects of this examination, thoſe ſubſtances to which ſome conſiderable medicinal virtues have been attributed, or which are employed for mechanic uſes. Thus the experiments anſwer a double end: At the ſame time that they ſhew, by particular examples, the chemical conſtitution of this or that kind of bodies, they enable us alſo to form ſome judgment about the medical uſes of the particular bodies. We ſhall find from them, that many of thoſe ſubſtances, to which phyſicians have aſcribed great virtues, and on which they have had ſome dependence even in caſes of importance, contain ſo much of a mere earth, give out ſo little to the force of boiling water or ſpirit, and this little of ſo inſignificant qualities, that their virtues may very juſtly be queſtioned.

I. OX-BONE.

OF the thigh-bone of an Ox, four drams, finely raſped, were thoroughly boiled in diſtilled water. The decoction, evaporated, left four ſcruples of a yellowiſh extract, which was found to be little other than Sea-ſalt. Rectified Spirit of Wine, long digeſted and boiled upon the raſped bone, extracted from four drams, no more than half a grain. The bone, remaining after the action of water, appeared unchanged in colour; but that which had been boiled in ſpirit, looked reddiſh.

The acid ſpirits of Vitriol, Nitre and Sea-ſalt, totally diſſolved it: The ſolution made in the vitriolic acid was yellowiſh, and ſhot into fine white cryſtals: Thoſe made in the nitrous and marine were colourleſs. Alcaline liquors had

Colouring and hardening of bones.] Bones and horns may be ſtained of a variety of colours, by ſteeping or boiling them in decoctions of the vegetable and animal ſubſtances by which woollen and ſilk are dyed. See the reſpective colouring drugs.

They are ſtained alſo, without heat, by metallic ſolutions; and by means of theſe may be ſpotted or variegated at pleaſure. Thus ſolution of Silver in Aqua fortis gives a brown or a black according to its quantity; ſolution of Gold in Aqua regia or in Spirit of Salt, a fine purple; ſolution of Copper in the acetous acid, a fine green; and ſolutions of the ſame metal in volatile alcalies, a blue, which at firſt is deep and beautiful, but changes, upon expoſure to the air, into a green or a bluiſh-green. If the bone or horn is but touched with the two firſt ſolutions, and expoſed to the air, it does not fail to acquire the colour in a few hours: In the two latter, it requires to be ſteeped for a day or longer in order to its imbibing the colour. In theſe and other caſes where immerſion for ſome time is neceſſary, the bone may be variegated by covering ſuch parts as are intended to remain white, with Wax or any other matter that the liquor will not diſſolve or penetrate.

There is a ſingular induration of bones produced by fire; the effects of which agent are here remarkably different, according to its degree and the circumſtances of its application. Bones expoſed to a moderate fire, either in open veſſels or in contact with the burning fuel, become opake, white and friable throughout; and an increaſe of the fire, after they have once ſuffered this change, renders them only more and more friable. But if they are urged at firſt with a ſtrong fire, ſuch as that in which Copper or Iron melts, they become hard, ſemitranſparent, and ſonorous like the hard mineral ſtones. This curious experiment deſerves to be further proſecuted.

OX-BONE. had little effect: Spirit of Sal ammoniac had none at all; and fixed alcalies, and caustic Ley, did but slightly corrode the bone: The volatile spirit received no colour; the caustic Ley, a yellowish one.

Two ounces of Ox-bone, distilled in a retort, in an open fire, gave over two drams of an empyreumatic phlegm, one dram of volatile urinous spirit, two scruples of volatile Salt, and two scruples of fetid Oil: The Caput mortuum weighed one ounce three drams and two scruples.

In another distillation of Ox-bone, I obtained, from sixteen ounces of the bone, eight ounces and a half of distilled matter; of which the urinous spirit made up four ounces six drams and a half, the volatile Salt half a dram; and the empyreumatic Oil three ounces five drams. The Caput mortuum weighed six ounces seven drams, and lost in calcination three drams: From the calx were elixated by water twenty-seven grains of fixed Salt.

II. HARTS-HORN.

THE branched horns of the HART or male red Deer (the female has none) are on their first appearance quite soft, and covered on the outside with a woolly matter: By degrees they contract a skin, which as the horn grows dry and hard, peels off. This animal sheds his horns every year; not as some suppose, from their mere weight, since they fall regularly at a certain season; nor from want of nourishment, since the most plentiful supply of food does not prevent it; nor from the young horns pushing out the old, for when the horns are sawed over short, the stumps never fall off; but solely, as Stahl has observed, from the action of cold, for young Harts, kept in warm stalls in the winter, do not lose their horns.

Sixteen ounces of Hartshorn, boiled with water, gave three ounces and three drams of strong firm gelly or gelatinous extract: From the residuum, rectified spirit extracted nothing. Spirit applied at first took up about four scruples from sixteen ounces; this extract consists not wholly of oily, but of oily and gelatinous matter.

From twenty-eight pounds of Hartshorn, distilled in an open fire, were obtained near five pounds and a half of a somewhat oily and urinous phlegm, thirty ounces of a volatile Salt, and above a pound of empyreumatic Oil (*b*): The remaining Coal or Caput mortuum weighed near seventeen pounds. The coal burnt to whiteness, dissolves both in the nitrous and marine acids, and is precipitated from them by the vitriolic: An ounce of Spirit of Salt dissolved, without much effervescence, two drams twenty-one grains; and an ounce of good Spirit of Nitre, three drams twenty-eight grains.

The

(*b*) *Produce of Salt*, &c.] The author's experiments were made upon the cortical part or tips of the horns, which contain more gelatinous matter, and yield a larger quantity of volatile Salt, than the internal medullary substance. On distilling a quantity of fragments of Hartshorn, consisting chiefly of pith, I found the proportion of volatile Salt to be only about half as much as in our author's experiment; five hundred and three pounds of the horns having yielded only sixteen pounds of rough Salt, with ninety-two pounds of rough Spirit and Oil.

The rough Salt of Hartshorn loses in rectification between one third and one half of its weight. Two pounds three ounces, on being rectified with Spirit of Wine, were reduced to one pound four ounces and a half.

The Jelly, volatile Salt, Spirit, and rectified Oil of Hartſhorn, are of more frequent uſe in medicine than thoſe of any other animal ſubſtance. Hartſhorn has been a particular favourite among the pharmaceutical chemiſts: Even its dead, fixed, indolent earth, deprived of all the active principles of the horn, has been celebrated as a medicine of extraordinary virtue. HARTSHORN.

Some prepare this earth, by ſuſpending the tips of the horns in the head of a ſtill during repeated diſtillations of ſimple waters, till the aqueous vapour has extracted the gelatinous parts, and rendered the horn pulverable; in which ſtate it is called Hartſhorn *philoſophically* prepared, or prepared *without fire*. Others boil the horn in water directly; and thus obtain, more expeditiouſly, a preparation juſt as philoſophical, and juſt as uſeleſs.

The horn calcined to whiteneſs in an open fire, and levigated into a fine powder, called ſimply *prepared Hartſhorn*, is ſtill more perfectly diveſted of its gelatinous parts, and reduced to a pure earth: This is ſometimes made an ingredient in powders for cleaning the teeth: It may likewiſe be of uſe for obtunding acid humours in the ſtomach, like other abſorbent earths; but on what pretence can we aſcribe to it cordial, diaphoretic, alexipharmac, or antifebrile powers? Some endeavour to improve the medicine, by grinding the earthy powder with Gold-leaf, and calcining the mixture till it acquires a purple colour: This preparation was formerly kept a ſecret; and if it was now forgotten, medicine would ſuffer no loſs.

III. CRANIUM HUMANUM.

HALF an ounce of the *Cranium humanum* raſped, gave, with rectified Spirit of Wine, two grains of an extract, which had no ſmell, and no particular taſte. The ſame quantity, treated with water, gave a dram of gelatinous extract, inodorous like the other, but in taſte ſomewhat ſaline. Spirit of Vitriol, and Spirit of Sea-ſalt, totally diſſolved the bone; but Spirit of Nitre left a ſmall portion undiſſolved: All the ſolutions were colourleſs; that made in the vitriolic acid ſhot into fine ſmall white cryſtals. Spirit of Sal ammoniac had no effect; ſolution of fixed Alcali corroded a little; and cauſtic Ley diſſolved almoſt the whole: Theſe alcaline liquors received no tincture any more than the acids.

By gradual diſtillation in a retort, I obtained from two ounces of the *Cranium*, of urinous liquor three drams and a half, of empyreumatic Oil half a dram, and of volatile Salt half a dram: The Caput mortuum weighed eleven drams and a half.

This bone, the natural defence of the ſeat of ſenſation and perception in the nobleſt animal, has been recommended medicinally as a cure for epilepſies, deliria, and all diſorders of the ſenſes . . . from the ſame philoſophy, which aſcribed antiaſthmatic virtues to the lungs of the long-winded Fox; and expected, becauſe fowls are ſaid to digeſt even ſmall ſtones, that the ſkin of the gizzard, dried and powdered, would produce a ſimilar effect in the human ſtomach——To ſuch lengths of extravagance have the ſons of phyſick been carried by the blind ſuperſtition of former ages!

IV. BOAR'S TUSK.

HALF an ounce of the TUSK of the WILD-BOAR, digeſted and boiled in rectified Spirit of Wine, gave three grains of extract, of a rancid taſte. The

BOAR'S TUSK.

ſame quantity yielded with water half a dram; this extract gave out marine vapours on the affuſion of Oil of Vitriol, and was found to conſiſt chiefly of common Salt. The bone, after boiling in ſpirit, looked reddiſh; but water made no change in the colour.

This bone was totally diſſolved by Spirit of Vitriol and Spirit of Nitre, and almoſt totally by Spirit of Salt; to the firſt it communicated a yellowiſh tinge, to the two latter none; from the firſt it cryſtallized, in form of a ſubtile Salt. Spirit of Sal ammoniac had no action on it; ſolution of fixed alcaline Salt corroded a little of it, without acquiring any colour; cauſtic Ley corroded almoſt the whole, and appeared of a pale Roſe-red.

From two ounces of the Tuſk, diſtilled in an open fire, there aroſe five drams and a half of urinous liquor, two ſcruples of empyreumatic Oil, and a dram and a half of volatile Salt: The reſiduum weighed one ounce and a ſcruple.

V. HIPPOPOTAMUS.

THE HIPPOPOTAMUS is an amphibious quadruped, inhabiting chiefly the large rivers of Africa and Aſia, as the Nile, the Niger, the Bamboth, the Zaire in the kingdom of Congo, *&c.* He is called *Hippopotamus* or river-*horſe* from the ſhape of his head, *Bupotamus* or river-*ox* from the hinder part of the body, and the river-*elephant* from the ſize of his fore-teeth. Bochartus endeavours to prove that this animal is the *Behemoth* mentioned in Job. When full grown, he is thirteen feet long, and twice as thick in the body as an Ox; the legs are ſhort and thick; the head is three feet in length and very thick, the mouth above a foot wide: The ſkin is remarkably ſtrong, being half an inch in thickneſs when dry, and hence it is uſed in ſhields for defence: A piece of the ſkin, and ſome other parts of the animal are preſerved in the Muſæum of the Royal Society.

The fore-teeth of the River-horſe are for the moſt part bent ſemicircularly, ſtriated longitudinally on the ſurface, with a deeper furrow in the curvature. They are hollow internally, but leſs and leſs ſo towards the extremity, which is pointed nearly like the tuſk of the wild Boar. They are of different ſizes: The largeſt weigh four pounds. They are extremely compact; ſo hard as to ſtrike fire with good Steel; externally of a yellowiſh-white colour, unleſs tarniſhed by age, or filth adhering to the unequal ſurface; internally of a fine white, which is leſs apt to change to a yellow than that of other bones. From their compactneſs and durable whiteneſs, they are employed like Ivory, for ſundry mechanic uſes.

This bone contains little oily or inflammable matter. From half an ounce, raſped into powder, I obtained, by digeſtion and boiling with Spirit of Wine, no more than one grain of extract, which was of a blackiſh-brown colour, and had very little taſte or ſmell. The ſame quantity being boiled with water, and the decoction evaporated, there remained thirty grains of a yellowiſh maſs, tenacious like Glue, and to the taſte quite ſaline. The bone remaining after the action of both menſtrua appeared unchanged in colour.

Spirit of Vitriol totally diſſolved it: Spirit of Nitre and Spirit of Sea-ſalt left a little flaky matter: The ſolutions in the vitriolic and marine acids looked yellowiſh, that in the nitrous, colourleſs: From the firſt, a ſmall quantity of

ſaline matter cryſtallized. Spirit of Sal ammoniac, ſtrong alcaline Ley, and cauſtic Ley, corroded a little of the bone, and acquired a yellowiſh tinge. HIPPOPOTAMUS.

Two ounces diſtilled in a glaſs retort, at firſt with a ſand-heat and afterwards with an open fire gradually increaſed, yielded four drams and a half of a volatile urinous empyreumatic liquor, and half a dram of a reddiſh-black empyreumatic Oil: The remaining coal weighed ten drams two ſcruples. During the diſtillation, an actual volatile Salt concreted about the ſides of the receiver, but on continuing the proceſs it was diſſolved and waſhed down, its quantity being too ſmall to be collected in its ſolid form.

VI. SEA-HORSE.

THE tooth of the SEA-HORSE has been generally confounded with that of the River-horſe, and ſubſtituted to it in the ſhops. The Sea-horſe, *Roſmarus, equus marinus, leo marinus, elephantus marinus*, is a large amphibious marine quadruped, found in the northern ſeas, about the coaſts of Greenland, Iceland, and Nova Zembla: It is called by the Germans the Horſe-whale. The teeth of this animal are naturally of a fine white, though we commonly meet with them tarniſhed to a yellowiſh: They are very hard and compact, more or leſs bent, pointed at the end like thoſe of the River-horſe, but leſs hollow, the hollowneſs reaching only a little way from the root: The largeſt weigh three pounds and a half. The ſkin of one of theſe animals has been known to weigh five hundred pounds. The tooth is uſed as Ivory, not only by the northern nations, but likewiſe among the Turks, Coſſacks, Perſians, *&c.* for ſword-hilts, hafts of knives, and a variety of toys. The teeth both of the Sea and River-horſes are made alſo into rings, necklaces, bracelets, *&c.* from a whimſical conceit of their being good againſt cramps.

From half an ounce of the fine raſpings of the tooth of the Sea-horſe, I obtained, by digeſtion and coction in Spirit of Wine, only half a grain of extract; and this ſeemed to proceed rather from ſome extraneous foulneſs adhering to the bone, than from the bone itſelf; it was of a browniſh colour, and had neither taſte nor ſmell. Another half ounce, boiled with diſtilled water, yielded twenty-five grains of a glutinous tenacious maſs, of a yellowiſh-white colour and ſaline taſte. The bone itſelf ſuffered no change in its colour either from water or ſpirit.

All the mineral acids diſſolved it; with this difference, that the nitrous and marine left a ſmall quantity of flaky matter, whilſt the vitriolic took up the whole: From the vitriolic ſolution a little white cryſtalline ſubſtance ſeparated, as from the ſolutions of other bones made in that acid. The nitrous ſolution looked yellowiſh. Alcaline menſtrua had no effect, except that a ſolution of fixed Alcali made the powder grey and blackiſh.

From two ounces of the raſped bone, diſtilled in a glaſs retort, at firſt in ſand and afterwards in an open fire gradually raiſed, were obtained a dram and a half of clear water, two ſcruples and a half of urinous, oily, empyreumatic liquor, two ſcruples of reddiſh-black fetid Oil, and a dram and a half of fine cryſtalline volatile Salt: The Caput mortuum weighed one ounce three drams and a half.

This tooth differs therefore, chemically, from that of the *Hippopotamus*, in giving out leſs to water and to ſpirit, and nothing to alcaline liquors; in being

SEA-HORSE. changed to a blackiſh grey colour by ſolution of fixed Alcali; tinging the nitrous acid yellow, and not the vitriolic; yielding in diſtillation leſs urinous liquor, more Oil and Caput mortuum, and much more volatile Salt, and not only an actual fetid ſalt, but what is remarkable, a cryſtalline one.

VII. IVORY. IVORY is a tuſk, or tooth of defence, growing at each ſide of the jaw of the male Elephant; the female has only the ſmaller grinding teeth. The Elephant is diſtinguiſhed from other animals by its ſize, its tuſks, its trunk or ſnout, (which it lengthens, ſhortens, and bends at pleaſure, and uſes as a hand,) and its thick roundiſh hoofs. It is the largeſt of all land animals, and remarkably docile. In Aſia and Africa, its native climates, great numbers are tamed and trained up by the grandees, for war, for carriage, for amuſement, and for ſhow. Du Verney diſſected an Elephant at Paris in 1681, and an abſtract of his obſervations is publiſhed in Du Hamel's hiſtory of the Academy of Sciences; but a much better and more particular anatomical deſcription of this animal may be ſeen in Ray's hiſtory of Quadrupeds.

The Elephant's tuſk is accounted by ſome not to be a tooth but a horn; becauſe, ſay they, it ſoftens in the fire, which horns do and teeth do not. Ivory, however, does not grow ſoft like common horn, but continues brittle, and by degrees calcines: Of horns, in the common ſenſe of the word, it is no character to grow ſoft in the fire; for thoſe of ſeveral animals, as the Hart and the Elk, do not. Ivory is a true and perfect tooth, and the largeſt tooth in the world. Sometimes it grows to an enormous ſize: Vartomannus ſaw two in Sumatra which weighed together three hundred and thirty-ſix pounds; and Linſchott mentions a ſingle one which weighed above two hundred pounds. The moſt common ſize, however, in trade, is from four to fifteen pounds, the very large ones being kept as curioſities.

The entire tooth is of a yelloviſh, browniſh, and ſometimes a dark brown colour on the outſide, internally white, hollow towards the root, and ſo far as was inſerted into the jaw of a blackiſh brown colour. The fineſt, whiteſt, ſmootheſt, and moſt compact ivory, comes from the iſland Ceylon. The grand conſumption of this commodity is for making ornamental utenſils, mathematical inſtruments, caſes, boxes, balls, combs, dice, and an infinity of toys. There are many exquiſite pieces of workmanſhip, as medals and chains, curious ſpinning-wheels, *&c.* made entirely out of one tooth. In his Pruſſian Majeſty's collection, there is a chair, a pair of cheſs tables, and ſundry other curioſities of ivory. The workmen have methods alſo of tinging it of a variety of colours.

Four drams of raſped ivory yielded, with rectified Spirit, three grains of extract, in taſte ſomewhat rancid, but of no ſmell: the remainder inclined a little to reddiſh. On boiling four drams in pure diſtilled water, and inſpiſſating the decoction, I obtained ſix drams of jelly or a gelatinous extract; but as the dried reſiduum weighed three drams and a ſcruple, it is plain that in the ſix drams of jelly there were only two ſcruples afforded by the ivory, all the reſt being water; and hence we learn, what a large proportion of water is retained in jellies. The jelly taſted manifeſtly ſaline; the remaining ivory proved conſiderably brittle and earthy.

Spirit

Spirit of Vitriol totally diſſolved raſped ivory: from the ſolution there ſeparated an elegant, white, ſparkling, ſilky, cryſtalline mixt, in appearance reſembling a ſalt, but neither ſaline to the taſte, nor diſſoluble in water; of the ſame kind alſo are the cryſtals obtained by this acid from the other ſolid parts of animals: the liquor, floating above the cryſtals, is apt to become yellowiſh, and at length brown. IVORY.

Spirit of Nitre and Spirit of Salt likewiſe diſſolved the whole of the ivory, but received no colour, and yielded no cryſtals. Spirit of Sal ammoniac had no effect: Alcaline Ley corroded a little of the ivory, without acquiring any tinge: Cauſtic Ley totally corroded it, and became ſomewhat yellowiſh.

Lemery ſays that ivory contains much Oil, volatile Salt and Earth, but little Phlegm: I have found on the other hand, that the Oil is in the ſmalleſt quantity of all theſe principles, and that the Phlegm is in larger quantity than either the Oil or Salt. From two ounces, diſtilled in a retort, I obtained three drams and a ſcruple of liquor, of which the firſt two drams ſmelt like ſope, and the reſt empyreumatic and urinous: This was ſucceeded by two ſcruples of fetid Oil, and two drams of volatile Salt. The remaining coal weighed ten drams.

The coal of Ivory is of a fine deep black colour; and hence is uſed as a pigment by the painters under the name of ivory-black; as alſo by the lapidaries, as a foil for precious ſtones; and by the japanners and varniſh makers, as an ingredient in their black compoſitions. There are particular machines and contrivances for burning the Ivory for theſe purpoſes; by which the colour is rendered more beautiful than that of the coal which remains in the diſtillation. Ivory-black.

If the Ivory-black be calcined in the open air, it changes into an earth of extreme whiteneſs: By deflagrating two parts of raſped Ivory with three of Nitre, it is quickly reduced into a ſimilar white powder, without any intermediate ſtate of blackneſs.

VIII. CARP-STONE.

THE CARP-STONE, *Lapis carpionum*, is found in the head of a fiſh, which is not the common carp, but the gilt charr, the *cyprinus* of Rondeletius. It is not, what Lemery calls it, the *os hyoides*, but a bone lodged in the *acetabulum*, at the juncture of the back bone with the head. When freſh, it is moderately tranſparent, like horn, in colour whitiſh or yellowiſh; by keeping it becomes more and more yellow and brown. In figure it is flat, and irregularly triangular.

Half an ounce of this bone, raſped ſmall, yielded with rectified Spirit of Wine five grains of extract, which taſted and ſmelt quite rancid, like old dry fiſh. From the ſame quantity, boiled in water, I obtained a dram of extract, of a yellow colour, in taſte purely ſaline, without any ſmell. The bone remaining after the action of Spirit, looked like tranſparent yellow amber; that which had been boiled in water looked grey.

Spirit of Vitriol corrodes only a little of the bone, and by that little is rendered turbid: Spirit of Nitre diſſolves nearly the whole, and acquires a yellow colour: Spirit of Salt diſſolves a little, and becomes likewiſe yellow. Spirit of Sal ammoniac has no effect: Alcaline Ley corrodes a little, receives no colour

CARP-STONE. colour itſelf, but makes the bone black: Cauſtic Ley diſſolves and corrodes a part, and acquires a yellow tinge.

Two ounces of the bone, diſtilled in a glaſs retort, in an open fire gradually raiſed, gave over half an ounce of liquor, of which the firſt three drams had an extremely ill ſmell, but the fourth the common urinous empyreumatic one: Then aroſe a dram and a half of fluid Oil, three drams of a thicker one, and three drams and a half of volatile Salt: The remaining coal weighed half an ounce.

IX. PERCH-STONE. THE PERCH-STONE, *Lapis percarum*, is a ſmall flat oval bone, hollowed a little at one ſide, in figure ſomewhat reſembling a flatted grain of Rice, of a gloſſy whiteneſs; found in the head, near the origin of the back-bone, not of the common Perch (*Perca major*) but of the ruff (*Perca minor, cernua, aſpredo.*)

Half an ounce of this bone, reduced to powder, yielded with rectified ſpirit only half a grain of extract, which had neither ſmell nor taſte. The ſame quantity gave with water two ſcruples and a half of a yellowiſh maſs, which was almoſt mere Salt. The bone itſelf ſuffered no change in its appearance from either menſtruum.

Spirit of Vitriol and Spirit of Salt, totally diſſolved the bone; Spirit of Nitre left a ſmall matter undiſſolved: The firſt acquired a yellowiſh colour and depoſited elegant cryſtals; the two others received no tincture, and yielded no cryſtals. Spirit of Sal ammoniac, alcaline Ley, and cauſtic Ley, corroded very little, and were not ſenſibly tinged.

In theſe experiments, the Perch-ſtone diſcovers no conſiderable differences from other bony ſubſtances; but its analyſis by fire is very ſingular and remarkable. Two ounces diſtilled in a glaſs retort, at firſt in a ſand-heat, and afterwards in an open fire, gave over bare half a dram of a clear liquor, juſt verging to yellowiſh, in ſmell only ſlightly volatile and empyreumatic: The greateſt force of fire would raiſe nothing more: There was neither Oil, nor volatile Salt, nor hardly any marks of an animal nature. The Caput mortuum however was a black coal, like that of other bones; it weighed two ounces as at firſt, wanting only the half dram of phlegmatic liquor.

X. JAW of the PIKE. THE PIKE is a freſh water fiſh of prey, with teeth only in the lower jaw, ſaid to be of great longevity, and to grow by age to a prodigious ſize: I have ſeen ſome of thirty and thirty-two pounds weight. There are none of theſe fiſhes in Spain; nor any name for them in that language.

Half an ounce of the lower jaw-bone of the Pike, reduced into powder, yielded with rectified ſpirit five grains of extract, of a rancid taſte, without any ſmell; the remaining powder looked reddiſh. From the ſame quantity were obtained by water three ſcruples and a half of a greeniſh-yellow maſs, conſiſting of a glutinous ſubſtance mixed with a large proportion of common Salt; the reſiduum appeared unaltered.

The vitriolic and nitrous acids totally diſſolved the bone; the marine left a ſmall portion undiſſolved: The ſolutions made in the two laſt were colourleſs; that in the firſt was yellowiſh, and depoſited a little cryſtalline matter. Spirit of

Sal ammoniac, common alcaline Ley, and cauſtic Ley, corroded only a little, and received no colour.

JAW of the PIKE.

From two ounces, diſtilled in a glaſs retort in an open fire, there aroſe a dram and a half of liquor of a lixivial ſmell, four ſcruples of liquor of the uſual empyreumatic ſmell, a dram of empyreumatic Oil, and a dram and a half of volatile Salt: The Caput mortuum weighed ten drams and a half.

XI. LAPIS MANATI.

THE MANATI or Sea-cow is a large animal, of a peculiar kind. It is ſtrictly an inhabitant of the ſea, but cannot live long without freſh water, and feeds on graſs and other vegetable matters; hence it is never ſeen but near the mouths of large rivers. It is met with in various parts of Aſia, Africa and America; but in none of the European ſeas. It has two very ſhort legs, which ſerve rather as hands than as feet, for though called amphibious, it never comes entirely on ſhore. It is very harmleſs, and eaſily caught. The female is viviparous, ſuckles her young like thoſe of the human ſpecies, and carries them conſtantly in her paws; hence it is called by the Spaniards and Portugueſe *la Donna*. The fleſh is ſaid to be much eſteemed in America, and the ſtrong ſkin to be uſed as a defence againſt the arrows of the Indians.

Certain bones found in the head of this animal, called *Lapides manati*, are expected to be kept in the ſhops for medicinal uſe; and the druggiſts do not fail to ſupply us with a great variety of bony ſubſtances under this name, very different from one another both in figure and in ſize, and none of them the genuine bones of the Manati: Hence the different accounts of the *Lapis manati* given by authors; ſome deſcribing it as of the ſize of a Hazel-nut, and others as large as a child's head. The Dutch put off cod's-head bones for thoſe of the Manati, and aſſure us that they come from America.

AS the true *Lapis manati* is not in this country to be procured, I examined the ſubſtance which is moſt generally ſubſtituted for it, namely the ear-bone of the Whale.

From half an ounce of this bone, by digeſtion and coction in rectified ſpirit, I obtained only one grain of an extract which had neither ſmell nor taſte: From the ſame quantity, treated with diſtilled water, I got a dram of a yellowiſh maſs, which had no ſmell but a very ſaline taſte, and which in effect was little other than mere common Salt. The powder ſuffered no change in colour from either menſtruum.

Spirit of Vitriol totally diſſolved the bone, depoſited a fine white cryſtalline matter, and became yellowiſh. Spirit of Nitre and Spirit of Sea-ſalt diſſolved nearly the whole, without receiving any colour. Spirit of Sal ammoniac had no effect. Common alcaline Ley, and cauſtic Ley corroded a little of the bone, but continued colourleſs: The powder, remaining after the action of the plain Ley, looked blackiſh.

From two ounces of the bone, diſtilled in an open fire, I obtained a dram of phlegm of a lixivial ſmell, a dram of volatile ſpirit or empyreumatic urinous liquor, half a ſcruple of fetid Oil, and half a dram of volatile Salt: The remaining coal weighed thirteen drams and a ſcruple.

HALF

XII. TALUS LEPORIS.

HALF an ounce of the ANCLE-BONE of the HARE, *Talus leporis*, yielded with rectified ſpirit fifteen grains, or one ſixteenth its weight, of an unctuous, yelloviſh-brown, tranſparent extract, of a rancid taſte and ſmell. Another half ounce, treated with water, gave a dram of a yelloviſh matter, which had no ſmell, and was almoſt mere Salt. Both the reſidua were of the ſame colour as at firſt.

By Spirit of Vitriol it was corroded; a part ſeparated in a cryſtalline form, and the reſt was reduced into a white powder. The ſpirits of Nitre and Sea-ſalt totally diſſolved it; the ſolutions were clear, with an unctuous matter on the ſurface, which in the nitrous acid was white, in the marine of a browniſh-yellow. Spirit of Sal ammoniac had no effect, except that it acquired a ſlight yelloviſh tinge, with a kind of cloudineſs towards the ſurface, as if a fine powdery ſubſtance was ſuſpended in it. Strong alcaline Ley took up more of the bone, and became yellower: Cauſtic Ley did not ſeem to diſſolve ſo much.

Two ounces diſtilled in a glaſs retort, at firſt in ſand and afterwards in an open fire, gave over two drams of a liquor of a quite ſopy ſmell, one dram of an empyreumatic urinous liquor or ſpirit, four ſcruples of empyreumatic Oil, and two drams of volatile Salt: The Caput mortuum weighed nine drams two ſcruples.

XIII. UNICORN'S HORN.

THE UNICORN is not a land animal of the Horſe kind, as ſome have repreſented it, but a ſpecies of Whale common in the northern ſeas, called by the Icelanders *Narhual* or *Narwal*, that is the Carrion-whale, its food being the carcaſſes of men and fiſhes. The horn, as it is called, is a large tooth fixed in the upper jaw: As the tuſks of the Sea-horſe are bent downwards, and thoſe of the Elephant, the Boar, and the oriental Wild-boar called Babyrouſſa, upwards; that of the Narwal ſtands horizontally, and in this reſpect only it differs from the fangs of thoſe animals.

The tuſk of the Narwal is very large; ſome have been ſeen of the length of nine or ten feet. It is pointed at the end, ſometimes irregularly crooked, in colour more or leſs white, generally wrinkled and undulated as if the bone was twiſted, ſometimes, but very rarely, of a ſmooth poliſhed ſurface. The part that had been inſerted into the jaw, is commonly of a yellower or browner colour, and more unſightly, than the reſt. Towards the root, there is often a conſiderable part hollow: I have been aſſured by the maſter of a Greenland veſſel that the hollow teeth are decayed ones which the animal has ſhed, and that the ſound ones, taken immediately from the Whale, are ſolid throughout. This tooth, like other bones, is made into various toys and utenſils: The Greenlanders uſe the tips for pointing their hunting weapons.

Half an ounce of this bone, raſped into powder, yielded with rectified ſpirit, two grains of an inſipid and inodorous extract. From the ſame quantity were obtained by water three ſcruples and a half of a browniſh-yellow, tenacious, unctuous maſs, of a ſaline taſte without any ſmell. The reſiduum, in both caſes, was of the ſame appearance as at firſt.

All the mineral acids totally diſſolved the bone, without receiving from it any colour; from the ſolution made in the vitriolic, a little cryſtalline matter ſeparated.

ſeparated. Spirit of Sal ammoniac and alcaline Ley had no effect; cauſtic Ley corroded a little of the bone. UNICORN'S HORN.

By diſtillation in a retort, in an open fire, I obtained from two ounces of the bone, of urinous ſpirit four drams, of an empyreumatic Oil half a dram, and of volatile Salt two ſcruples and a half: The Caput mortuum weighed ten drams two ſcruples.

SECT. VI.

Earthy Parts of ANIMALS.

HORNS and bones conſiſt in great part of an earth, but are nevertheleſs very diſtinct from the bodies of the preſent diviſion. The earthy parts of animals, more ſtrictly ſo called, are of a much leſs compact texture than the horny and bony, and want not only the flexibility of the one but the hardneſs of the other. They break far more eaſily by a blow, and are reducible in the mortar into powder. They yield in general leſs oily and ſaline matter in diſtillation, and contain in their natural ſtate leſs gelatinous matter; whence they diſſolve, not only in the ſtrong mineral acids, but in the milder acids of the vegetable kingdom, the gelatinous parts being inſufficient to cover and defend the earth from the action of the acids. EARTHY.

Of this kind are moſt of the teſtaceous and cruſtaceous coverings of animals, and many calculous concretions. The pure earthy part is not in all theſe ſubſtances the ſame, nor are the particular differences ſufficiently known. The only conſiderable difference that has been obſerved, is, that ſome are converted by fire into a ſtrong Quick-lime, whilſt others ſuffer no ſuch change. [See page 493.]

CLASS I.

Earthy Subſtances not convertible by Fire into Quick-lime; and whoſe Earth ſeems to be ſimilar to that of Bones and Horns.

OF all the ſubſtances of this claſs, and indeed of all the earthy parts of animals, the moſt valuable and remarkable is the PEARL; which from its beauty and luſtre is ranked among the precious ſtones, though it has nothing of their diſtinguiſhing hardneſs. PEARL.

Pearl is no other than a calculus, or morbid concretion, produced in a certain ſhell-fiſh of the Oyſter kind, and ſometimes in common Oyſters and Muſcles: It is ſometimes formed upon the inſide of the ſhell, and ſometimes in the body of the animal. Shells in general appear to proceed from peculiar nutritious juices, regularly ſecreted and indurated; and Calculi, from a redundance of

PEARL. thoſe juices, or a ſtagnation and unequal diſtribution of them occaſioned by an obſtruction of the veſſels.

Pearl-fiſhery. The Mother-of-Pearl fiſh, or Pearl oyſter, is an inhabitant of the bottom of the ſea: There it abides fixed, and is not to be come at but by diving. A number of ſmall ſhips is generally engaged together in this dangerous buſineſs, on ſuch particular ſpots as have been found to be rich in the Pearl-fiſh, and at certain ſeaſons of the year. The divers are let down by ropes, and immediately drawn up again upon their pulling a bell as a ſignal for that purpoſe. Machines have been contrived for enabling them in ſome degree to breathe at the bottom, by means of pipes reaching above the ſurface and communicating with the external air, or by a quantity of air included and carried down with them: See ſome papers upon this ſubject in the Philoſophical Tranſactions. Suffocation however is not the only danger to which the divers are expoſed: They are ſubject to ruptures of ſome of the veſſels from the vaſt preſſure of the water at great depths, and to be wounded or devoured by fiſhes of prey, which ſome of the rich beds of Pearl-fiſh are ſo much infeſted with, that ſcarcely any one can venture down at all.

After the Pearl-oyſters have thus been got up, there ſtill remains a proceſs, not a little prejudicial to health, and extremely offenſive. If the ſhells were opened directly by any violent means, the Pearls, ſaid to be at this time in a ſomewhat ſoft ſtate, would be liable to be injured, and become of little value. The whole are therefore laid in heaps, till the ſhells open ſpontaneouſly, and the fiſh putrefies; after which the corrupted cadaverous matter is ſearched diligently for the Pearls, which are often too few to pay the expence of the proprietors, much leſs to make any recompence to the workmen for a ſervice ſo loathſome and ſo hazardous.

Different ſorts and places of production. Pearls are uſually divided into oriental and occidental; the firſt produced in Aſia and Africa, the latter in America and Europe. The principal oriental Pearl fiſheries are in the Perſian gulf and on the coaſts of Perſia and Arabia, of which a chart may be ſeen in Kæmpfer's *Amænitates Exoticæ*; near the iſlands Ceylon, Manaar, Sumatra, Java and Borneo; on ſome of the coaſts of Japan; between Banana and Cochin, off Cape Comorin, and in other parts along the Malabar coaſt, as particularly at Tutogrin or Tutocoryn, where there is an excellent Pearl bank in poſſeſſion of the Dutch. The moſt remarkable Pearl-fiſheries of America are in the gulf of Mexico, along the coaſt of New Spain, off St. Margarite or the Pearl-iſland, in the Rio de la Hacha, at the iſlands St. Martha, Quibo, Gorgonia, *&c.* In Europe, Pearls are now and then met with on the coaſts of Scotland, Livonia, Courland, in the river Ilts in Bohemia, in the Regen in Bavaria, in certain lakes near Augſburg, and in ſundry other places.

The oriental Pearls are accounted the beſt; and, conſidered collectively, they certainly are ſo, though this ſuperiority by no means extends to all the individuals: There are ſome, among the occidental, of exquiſite luſtre and great value; and many millions, among the oriental, coarſe and unſightly.

Even among the better kinds of oriental Pearls, there are very conſiderable differences: Borneo affords the largeſt, and Ceylon and Manaar the whiteſt: Thoſe of Sumatra, Java, Panana, Cochin, and the Malabar coaſt, are for the moſt

moſt part ſmaller and leſs fine: Thoſe of the Perſian gulf have generally ſome- PEARL.
what of a yellowiſh caſt, but as they conſtantly retain this tinge, and have an excellent luſtre, they are accounted the beſt, and ſome confine the name of oriental to theſe alone.

There are Pearls of various colours, figures, and magnitudes; of an exquiſite Silver-like brightneſs, ſemitranſparent, opake, opal-coloured, yellow, greeniſh, bluiſh, greyiſh, reddiſh, browniſh, blackiſh, rainbow-coloured; round, oval, conical, cylindrical, angular; from the ſize of a Millet-ſeed or leſs, to that of a Hazel-nut and more: It is obſervable that the large ones approach generally to the figure of a Pear. The largeſt Pearl hitherto known is deſcribed by Tavernier, and is in the poſſeſſion of the King of Perſia; it was found at Catifa in Arabia, and coſt 1,400,000 French livres. Some years ago, there were two very large ones to be diſpoſed of at Leipzick, weighing together above ninety carats: The author above-mentioned had one that weighed fifty-five carats: A carat is three grains and a half. I have ſeen a Pearl in the Engliſh crown, which is ſaid to be worth ten thouſand pounds ſterling. Sir Robert Sibbald ſays in his *Scotia Illuſtrata*, that Pearls have been found in Scotland of a very large ſize.

Pearls are valued from their roundneſs, their ſize, and their water, that is Their valuatheir luſtre and purity. Their weight is eſtimated in Europe by carats; in tion.
Perſia by *abas*'s, and in Golconda and Viſapour by *ratis*, each abas and rati being one eighth part leſs than a carat.

The weight of round Pearls is expeditiouſly judged of, by means of a ſmall inſtrument compoſed of ſeveral ſlips of Braſs full of holes of different ſizes: The ſmalleſt hole receives a Pearl of one or two grains; and the largeſt, one of ten carats; and thus the weight of any given round Pearl is known from the hole which it fits.

Small irregular ones are valued from the number that goes to an ounce: If a hundred make an ounce, they are valued at an hundred rixdollars; if the number is leſs, the price is greater; and if the number is greater, the price is leſs: Two hundred to the ounce coſt but ſeventy rixdollars; three hundred, fifty; nine hundred, ten; two thouſand, three; four thouſand, two and a half: Of the very ſmall ſort called Seed-pearls, uſed in medicine, an ounce contains uſually eight or ten thouſand, and coſts, if the Pearls are of the oriental kind, two rixdollars, if occidental one rixdollar and twelve groſchen (*c*).

Attempts have been made to take out ſtains from Pearls, and to render the Cleaned.
foul, opake, coloured ones equal in beauty and luſtre to the oriental. Abundance of proceſſes are given for this purpoſe in books of ſecrets and travels; but they are very far from anſwering what is expected from them. Pearls may be cleaned indeed from any external foulneſs, by waſhing and rubbing them with a little Venice Sope and warm water, or with ground Rice and Salt, with Starch and Powder-blue, with Plaſter-of-Paris, with white Coral, with white Vitriol and Tartar, with Cuttle-bone, Pumice-ſtone, and other like ſubſtances; but a ſtain that reaches deep into the ſubſtance of the Pearl is impoſſible to be taken out. Nor can a number of ſmall Pearls be united, as ſome pretend, into a maſs ſimilar to an entire natural one.

There

(*c*) *Rixdollar.*] A rixdollar is equal to 4 *s.* 6 *d.* A groſſchen about 2 *d.*

PEARL. Artificial. There are however methods of making artificial compoſitions, equally ornamental with the natural Pearls, and difficultly if at all to be diſtinguiſhed from them by the eye. Moſt of theſe are prepared in France and Italy, and ſome in Spain: The beſt conſiſt of a hollow glaſs ball, blown by a lamp, and filled with Wax: Some pour in firſt a ſolution of a certain Amalgam, and then fill up the ball with Wax: Others uſe Wax without Glaſs, and by certain additions communicate a Pearl colour on the outſide. This curious art is kept a ſecret in the hands of the workmen (*d*).

Chemical examination. Powdered Pearl gives out nothing to water or to rectified ſpirit, by long digeſtion or coction. It diſſolves in the mineral acids, totally in the vitriolic, and almoſt totally in the nitrous and marine, without communicating to them any perceptible tinge: From the ſolution in the vitriolic acid there ſeparates a cryſtalline matter, in appearance reſembling a Salt. It is not acted upon by Spirit of Sal ammoniac or cauſtic Ley: By plain alcaline Ley a little of the Pearl was corroded into a flaky ſubſtance.

Four drams of Pearl, diſtilled in a glaſs retort with an open fire gradually increaſed, gave over fourteen grains of an empyreumatic urinous liquor, of a volatile ſmell, with ſome footſteps of an empyreumatic Oil in the neck of the retort. The Caput mortuum was of an aſh-grey colour, and weighed three drams two ſcruples ſix grains: This being further calcined in an open veſſel, then elixated with water, and the Lixivium filtered and evaporated, I obtained five grains of a fixed Salt, which appeared of a fine white colour, had a warm not very ſaline taſte, effervеſced with Oil of Vitriol, and during the effervеſcence diſcharged in vapour a little marine acid.

All theſe experiments were performed both upon oriental and occidental Pearls; and no difference could be obſerved betwixt the two, either in the quantity or quality of the products, excepting that the occidental Pearls yielded in diſtillation four grains more of liquor than the other, and that the Caput mortuum of courſe weighed four grains leſs.

II. BEZOARS. STONY concretions are formed in many land animals; in the ſtomach of Goats, Harts, Horſes, Aſſes, Cows, *&c.* as well as in the urinary and gall-bladder of the human body (*e*). Several of theſe ſubſtances were by the credulity

(*d*) *Artificial Pearls.*] The ingredient employed for giving the colour is a fine Silver-like ſubſtance found upon the under-ſide of the ſcales of the Blay or Bleak-fiſh. The ſcales, taken off in the uſual manner, are waſhed and rubbed with freſh parcels of fair water, and the ſeveral liquors ſuffered to ſettle: The water being then poured off, the pearly matter remains at the bottom, of the conſiſtence of Oil, called by the French *Eſſence d'orient.* A little of this is dropt into a hollow bead of bluiſh Glaſs, and ſhaken about ſo as to line the internal ſurface; after which, the cavity is filled up with Wax, to give ſolidity and weight. By this means Pearls are imitated in ſuch perfection, as not to be diſtinguiſhable by the eye from the natural, or to be diſtinguiſhable only by their having fewer blemiſhes. See a Memoir on this ſubject by M. de Reaumur, in the *Mem. de l'Acad. Royale de Sciences* (*de Paris*) *pour l'ann.* 1716.

(*e*) *Human calculus.*] This concrete varies greatly in conſiſtence: Sometimes it is of a looſe texture, and almoſt friable betwixt the fingers; ſometimes very hard and compact, and capable of receiving a conſiderable

dulity of former times celebrated as medicines of extraordinary virtue, and diſtinguiſhed by an oriental name, BEZOAR, which is ſaid to ſignify a ſubduer of poiſons or a lord over poiſons; hence *Bezoardic* is become a common appellation [in Germany, *&c.*] for all medicines ſuppoſed to be poſſeſſed of alexipharmac powers. The Bezoar of the Ape, and that of the Porcupine called *Piedra del porco* have been valued moſt: Single ſtones have been ſold for ſixty and eighty pounds ſterling. BEZOARS.

There are two Bezoars kept in the ſhops, diſtinguiſhed from the countries whence they are brought, by the names of oriental and occidental.

THE oriental or beſt Bezoar is found in the ſtomach of an animal, which is ſaid to bear a reſemblance both to the Goat and the Stag, to the former in the horns, beard, and tail; to the latter in the body, feet and hair; called by ſome *Cervicapra* and by others *Capricerva*, by Ray *Gazella indica cornubus rectis longiſſimis nigris prope caput tantum annulatis*. The animal is deſcribed and figured by Kæmpfer, in his *Amœnitates*, and ſaid to be met with in different parts of Perſia, China and the Eaſt-Indies. Thoſe who feed upon mountains, on aromatic herbs, are ſuppoſed to afford a better Bezoar than thoſe on plains and vallies. ORIENTAL BEZOAR.

The Bezoar-ſtone is generally obſerved to be formed about ſome vegetable matter which the animal has ſwallowed, and which is often found in the middle of the ſtone upon breaking it; as a bit of ſtraw, wood, ſtalk or rind of plants, *&c.* This nucleus is gradually covered with ſucceſſive incruſtations, one over another, which, by conſtant motion in the ſtomach are rendered externally ſmooth and poliſhed. Such at leaſt is the common opinion of the production of Bezoar.

There

able poliſh. In either ſtate, particularly in the latter, it is difficult of ſolution even in the ſtrong mineral acids. The deſirable point, a menſtruum that ſhall diſſolve it and at the ſame time be innocent to the body, has hitherto been ſought for in vain.

There are, however, ſubſtances held to be inoffenſive, which though they do not make a perfect ſolution of the Calculus, are nevertheleſs found to ſoften and corrode it by degrees into a kind of mucous or powdery matter; and which, when freely taken into the ſtomach, have ſeemed to carry their virtue through the organs of digeſtion, and impregnate the urine with ſome degree of this lithontriptic power.

Such particularly are Lime-water and Sope; of which the former appears to be the moſt efficacious. According to Dr. Whytt's experiments, the power of Stone-lime-water is near one third greater than that of ſolutions of Sope in common water; and that of Oyſter and Cockle-ſhell Lime-waters, above double to that of Stone-lime-water. He finds that the activity of the Shell-lime-water alſo may be almoſt doubled, by pouring upon the calcined ſhells a ſtrong ſolution of Sope inſtead of common water.

Alcaline Ley made cauſtic by Quick-lime, and the cauſtic volatile ſpirits diſtilled with Quick lime from Sal ammoniac or inſpiſſated urine, corrode the Calculus very plentifully. According to the author above-mentioned, the ſtrength of a cauſtic Ley, made from only an ounce of Pot-aſh and two ounces and a half of Quick-lime to a pound and a half of water, was about ſix times greater than that of Oyſter-ſhell Lime-water. The plain volatile ſpirits are far leſs active; and plain alcaline Ley, though loaded with the Salt, has ſcarce any effect at all upon the Calculus.

ORIENTAL BEZOAR. There are Bezoar-ſtones of various figures, colours, and magnitudes; ſome round or oval, others long, flat, kidney-ſhaped; ſome compoſed of very thin, and others of thicker incruſtations; ſome greeniſh, verging more or leſs to yellow or blackiſh, others of a browniſh, greyiſh, or blackiſh colour without any greenneſs. The largeſt are about the ſize of a ſmall Hen's egg: The Emperor Rudolphus II. had a Bezoar-ſtone larger than a Gooſe-egg; but Boetius de Boot ſays it was white and light, and diſſolved eaſily upon the tongue; from whence it appears plainly not to have been a natural ſtone but an artificial compoſition. The large, compact, ſmooth and ſhining ones, are preſerved as curioſities: For medicinal uſe, we muſt be ſatisfied with the ſmaller and coarſer; and even theſe are at preſent ſcarcely to be purchaſed for money.

The marks uſually laid down for judging of the genuineneſs of Bezoar are, that it be of middling ſize, about that of a Pigeon's egg, compact, even, ſoft or ſmooth to the touch, of a ſhining ſurface, and a browniſh, greyiſh, or olive colour: That on ſucceſſively taking off the ſeveral incruſtations, the inner ones be all of poliſhed ſurfaces like the outer: That when reduced into powder, it appear of a fine green colour: That it have a cavity in the middle, without any vegetable or other matter encloſed: That a red-hot needle do not pierce into it: That it neither gain nor loſe any weight by ſoaking in warm water: That when the moiſt ſtone is rubbed upon dry Lime or on a wall white-waſhed with Lime, or the dry ſtone rubbed upon moiſt Lime, it ſtain the Lime green; ſome make a purple, others a cheſnut-brown, and others a yellow ſtain, the mark of its genuineneſs: That in like manner it give a green ſtain to paper rubbed with Chalk: That it make a ſtrong efferveſcence with Spirit of Nitre, and tinge the menſtruum of a dark red colour: That it do not diſſolve in Spirit of Wine; and that it be neither very heavy nor very light. Theſe are all the characters of the true natural Bezoar, mentioned by authors, and it were eaſy to ſhew that they are all imitable by art.

The Indian writers, and many perſons of good credit who have been in Perſia and the Indies, affirm, that the greater number of Bezoar-ſtones are no other than artificial compounds made there; that ſome prepare them from ſmall Bezoar ſtones reduced into fine powder and made up into a maſs; but that theſe are very rare, the common ones being made of different ingredients without any thing of the true Bezoar. Kæmpfer ſays, that the genuine Bezoar is in Perſia itſelf ſo rare and ſo dear, that he cannot believe that a ſingle ſtone comes into Europe. Many others agree in this account; and indeed the Bezoar-ſtone carries in itſelf ſtrong marks of art, but hardly any traces of its being formed by nature.

It is principally in the urinary and gall-bladders, in the kidneys and in the ſtomach of animals, that Calculi are produced; it is very rare to meet with any in the inteſtines, the lungs or other parts. The ſtones of the kidneys and urinary bladder are commonly compoſed of different ſtrata or incruſtations, often ſmooth and heavy like mineral ſtones, but oftener rough, ſpongy, light, and full of inequalities or protuberances: Chemically analyſed, or diſtilled in an open fire, they yield nearly the ſame principles as urine itſelf, or at leaſt an empyreumatic volatile urinous matter: They never have, and cannot have, any

vegetable matter, graſs, pieces of roots, fruits, ſeeds, *&c.* for a nucleus—— The gall ſtones are commonly yellow, orange-coloured, green, of a blackiſh-greeniſh-brown, or a colour compoſed of green and yellow: They are often made up of incruſtations, ſeldom compact, but rather brittle and ſpongy, and without any foreign matter within: In diſtillation, they yield the ſame principles as gall——The balls, or ſtones as they are called, formed in the ſtomach, conſiſt of ſuch matters as the animal has ſwallowed, hair, ſtraw, hay, herbs, roots, rinds *&c.* imperfectly or not at all digeſted, and held together by the mucus or ſlimy juices of the part: Theſe rarely have any incruſtations; externally they are ſometimes ſmooth, and ſometimes not; they are uſually the lighteſt of all the calculous concretions, and of the ſtrongeſt ſmell, which in ſome is offenſive, and in others agreeable——When ſtones are found in the inteſtines, they generally contain ſome indigeſted matters, and ſmell of the place they were lodged in. ORIENTAL BEZOAR.

Now where could the Bezoar-ſtone have been formed; a ſtone compoſed of ſuch fine, equal, regular, poliſhed incruſtations, with a cavity or extraneous body in the middle? It cannot be produced in parts where thoſe bodies do not enter, becauſe they are oftentimes actually found in it: It cannot be produced in thoſe parts where they do enter, becauſe then they would be intermixed through its whole ſubſtance as in the balls found in the ſtomach. How uniform are all the ſtrata in one Bezoar-ſtone! how equal throughout in hardneſs, brightneſs and poliſure! and yet how different are different ſtones in all theſe reſpects from one another! Such a regularly-formed concrete is not ſurely the reſult of a fortuitous accumulation and induration of matter tumbling in the paunch of an animal.

Oriental Bezoar-ſtones, chemically conſidered, may be divided into two claſſes; thoſe which are ſuppoſed to be genuine, and thoſe which are acknowledged to be counterfeit. The firſt are compounded of Plaſter-of-Paris, Chalk or other earths, impregnated with a vegetable green tincture: The latter are made chiefly of reſinous ſubſtances, diſtinguiſhable by their liqueſying in the fire, and diſſolving in Spirit of Wine. I have examined ſeveral of both ſorts, but never could diſcover any mark of an animal nature; though an animal ſubſtance, where or whatſoever it be, cannot eſcape diſcovery in a chemical enquiry. If ſome ſtones, however, ſhould give out an urinous empyreumatic matter in the fire, it would not follow that they are natural productions, as an animal Glue may be uſed, and according to ſome accounts often is uſed for the conglutinating ingredient.

We may add to the foregoing a third claſs of Bezoars, made up with gums, with extracts, or with inſpiſſated juices: Theſe are very rare; they are diſtinguiſhed by their diſſolving in great part in water. I have ſeen and taſted ſome of this kind at Frankfort upon the Maine and at Leghorn, but could not procure any for examination.

A fine, choice oriental Bezoar-ſtone, of the genuine kind (that is, of thoſe compounded of earths) being reduced into fine powder, and a ſcruple of the powder digeſted in a glaſs body with a ſuitable quantity of rectified Spirit of Wine, the ſpirit acquired a greeniſh-yellow colour, and on being evaporated, left

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left behind a minute portion, ſcarce amounting to one grain, of a blackiſh extract, of no remarkable ſmell or taſte.

On boiling another ſcruple of the powder in diſtilled water, the event was the ſame: The water acquired a green tinge, and left on evaporation, ſcarcely one grain of an extract ſimilar to the former. The powder remaining after the action of both liquors appeared unaltered.

A ſcruple of the counterfeit reſinous Bezoar digeſted in rectified ſpirit, yielded ſeventeen grains of extract, only three grains remaining undiſſolved: The extract was of a yellowiſh-green colour, reſinous, ſtuck to the teeth, taſted bitteriſh, and ſmelt diſagreeably.

With water, I could ſcarcely get half a grain of extract from a ſcruple of this kind of Bezoar, though the powder was long digeſted and boiled in the liquor: The extract had a bitteriſh taſte, without any ſmell: The reſiduum was in ſmell, taſte, and colour unaltered.

The powder of the earthy Bezoar was not acted on by Spirit of Vitriol. To Spirit of Nitre, it inſtantly communicated a red colour, and raiſed an effervescence: The liquor continued of a dark red ſo long a it was kept in the cold, but on applying heat, it preſently became of a bright yellow, and diſſolved all the Bezoar, excepting a very ſmall quantity of flaky matter. Spirit of Salt acquired a fine yellow colour, and the undiſſolved powder appeared of a greeniſh yellow. Spirit of Sal ammoniac extracted a browniſh-yellow tincture, and left the powder reddiſh at top and aſh-coloured underneath. Alcaline Ley was tinged of a bright brown; the powder unaltered: Cauſtic Ley, of a dark reddiſh-brown; the powder of a Sulphur yellow.

The reſinous Bezoar ſwam upon Spirit of Vitriol, like other reſinous bodies, and was not ſenſibly acted on. About one half of it diſſolved in Spirit of Nitre, and tinged the liquor yellowiſh, the reſt melting together and ſwimming on the ſurface. Spirit of Salt received no colour; as ſoon as it was poured on, the powder melted all into one maſs and roſe to the top. In Spirit of Sal ammoniac, it fell to the bottom, unacted on. In alcaline ley, it floated, and appeared curdly like Sope; the liquor looked yellowiſh. Cauſtic ley diſſolved greateſt part of it, and became in like manner ſopy, and thick like Mucilage.

Two drams of the earthy Bezoar were diſtilled in a glaſs retort, in a well graduated open fire. So long as the heat was continued gentle, the powdered ſtone retained its original colour, and the liquid which came over proved colourleſs as water. As the heat was increaſed, the drops grew yellowiſh, and at laſt of a deep yellow; the powder at the ſame time acquiring a Sulphur yellow colour on the ſurface; a little Sublimate of the ſame colour ariſing into the neck of the retort: There now appeared at the bottom, at one ſide, where perhaps the heat was greateſt, a conſiderable lump of curious ſaline ſpicula, exactly reſembling flowers of Benzoine. When the matter became red-hot, a ſmoky vapour aroſe, which changed the upper part of the yellow Sublimate to a ſooty blackneſs. The diſtilled liquor amounted in all, to three ſcruples and a half; it had an empyreumatic ſmell and taſte, like Spirit of Tartar, without any

any thing of the volatile urinous ſmell produced from animal ſubſtances. The yellowiſh Sublimate weighed three grains, ſmelt like old ſmoky tobacco-pipes, and taſted ſomewhat ſaline. The ſooty Sublimate weighed but one grain; it was partly ſhining, very light, of no ſmell or taſte. The Caput mortuum weighed two ſcruples ſix grains, was very black, light, and had not melted or run together. ORIENTAL BEZOAR.

Two drams of the reſinous Bezoar being treated in the ſame manner, the powder flowed thin in a gentle heat, like Wax or Reſin. On increaſing the fire there aroſe a ſcruple of yellowiſh empyreumatic liquor, and afterwards a dram and thirty-two grains of a blackiſh-brown empyreumatic Oil, in ſmell exactly reſembling the fetid Oils obtained from other Reſins. In the bottom of the retort there remained but eight grains of a black, ſpongy, friable coal.

THE occidental Bezoar is ſaid to be found in the ſtomach of an animal of the ſame genus with that which affords the oriental. This ſort of Bezoar is not near ſo beautiful, ſo ſmooth, or ſo poliſhed as the other: It is commonly of a whitiſh, aſh, or dark-grey colour; ſometimes browniſh or blackiſh; and ſometimes of a greeniſh-yellow. OCCIDENTAL BEZOAR.

A ſcruple of occidental Bezoar, digeſted with rectified Spirit of Wine, gave only half a grain of extract, of a yellowiſh-green colour, a ſomewhat rancid taſte, and no ſmell: The remaining powder appeared unaltered. Diſtilled water extracted alſo but half a grain from a ſcruple: This extract was of a greeniſh-brown colour, and had neither taſte nor ſmell.

Spirit of Nitre and Spirit of Sea-ſalt diſſolved greateſt part of the Bezoar, and Spirit of Vitriol the whole: All the ſolutions were yellowiſh: From that made in the vitriolic acid, a little cryſtalline matter ſeparated.

Spirit of Sal ammoniac, common alcaline Ley and cauſtic Ley did not diſſolve any ſenſible quantity of the powder, but acquired from it a yellowiſh tinge; the cauſtic Ley gained the deepeſt yellow.

On diſtilling two drams in an open fire, there aroſe twenty-two grains of a browniſh-yellow liquor, of an empyreumatic and ſomewhat volatile ſmell; on the ſurface of which ſwum two little drops of an empyreumatic Oil: The Caput mortuum weighed one dram and thirty-eight grains; it was quite black, and continued a ſubtile powder like the Bezoar employed.

From theſe experiments it appears, that the occidental Bezoar is more likely to be an animal production than the oriental, as it yields in diſtillation ſome ſmall portion of volatile urinous matter. It is nevertheleſs much inferior in value, as being leſs beautiful, and ſcarcely ever made uſe of in medicine. If the oriental and occidental Bezoars were both genuine, or true animal calculi, they would probably be equal in virtue to one another, though aſſuredly not equal to Oyſter-ſhells and other common abſorbents.

III. OCULI CANCROR.

CRABS-EYES, improperly ſo called, are neither eyes, nor the produce of the Crab; but Calculi found in the ſtomach of the Craw-fiſh or *Aſtacus fluviatilis*.

The Craw-fiſh caſts its ſhell every year, and it is only during the little time that the new ſhell continues ſoft, that the animal can increaſe in bulk: As the

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ſhell hardens and confines the fiſh, a white nutritious juice, ſecreted in two portions of the ſtomach, forms by degrees a ſoft calculous ſubſtance, of a cruſtaceous texture from ſucceſſive appoſitions of the juice. Before the caſting of the ſhell, the ſtunted animal grows weak and ſick, and for ſome days lies almoſt dead: It does not take food till ſome days after, and in this period, the Calculi ſeem to ſerve for its aliment. Hence we meet with Crabs-eyes (for ſo we muſt call them in compliance with cuſtom) both in young and in old Crabs before they loſe their ſhells, and for a few days afterwards, and not in one or the other for a conſiderable time after that period.

Crabs eyes are of different ſizes, hemiſpherical or convex on one ſide, flat or concave on the other, of a bluiſh, white or reddiſh-white colour, of a leafy ſtructure, moderately firm and compact: There are ſmall ſtriæ upon the convex part, and irregular impreſſions in the concavity.

Some prefer the blue ſtones, taken from the live fiſh, on a ridiculous principle, that they are impregnated with the animal ſpirits, which by boiling are diſſipated. Thus much however it is proper to obſerve, that the blue colour is deſtroyed by boiling the fiſh, and that ſalt water inclines it more to reddiſh than freſh water. They loſe their blueneſs alſo by long keeping. When the bluiſh tinge is ſo pale as not to be diſtinguiſhed in the dry ſtone, it becomes perceptible on pouring hot water upon them; when long kept, they exhibit no blueneſs either moiſt or dry.

Crabs-eyes have been often counterfeited with artificial compoſitions of different earths, particularly Chalk, Plaſter-of-Paris and tobacco-pipe Clay, formed in moulds. Theſe are commonly whiter and lighter than the genuine, imbibe more water, adhere more ſtrongly to the tongue, and have leſs diverſity of figures or characters in the concave part. But the more certain criteria are, that they want the leafy texture of the genuine, and are affected in a different manner by acids. A counterfeit Crabs-eye, put into diluted Aqua fortis, diſſolves either wholly, or by piece-meal, or not at all, whilſt the genuine, though great part of it is diſſolved, retains its figure, its earthy baſis being extracted by the acid, and the gelatinous conglutinating matter left entire, but porous like a ſponge.

This experiment does not ſucceed with undiluted Aqua fortis; for the concentrated acid, acting more violently on the ſtone, whilſt it diſſolves the earthy matter, divides and diſunites the gelatinous, of which we can now diſtinguiſh only a few flakes.

The nitrous acid diſſolves a larger quantity of Crabs-eyes than any of the others: An ounce of good Spirit of Nitre takes up four drams; the ſame quantity of Spirit of Salt, only three drams. The vitriolic acid, whether concentrated or diluted, diſſolves exceeding little; an ounce either of the Spirit or Oil of Vitriol extracting but five or ſix grains. The mild vegetable acids, Vinegar, Lemon-juice, *&c.* take up about as much. Neither water nor rectified ſpirit extract any thing at all.

Sixteen ounces of Crabs-eyes, diſtilled in an open fire, give over three ounces and a half of liquor, ſlightly urinous and empyreumatic: The remaining coal, burnt to white aſhes, yields on being elixated with water a ſcruple of fixed Salt.

THE

IV. CUTTLE-BONE.

THE CUTTLE-BONE, ſo called, has nothing of the hardneſs or texture of bones: It is a white brittle ſubſtance, ſo light and fungous that the Dutch call it *Zee-ſchuym*, Sea-ſcum. It is produced on the back of the Cuttle-fiſh, and has on its upper ſurface a cruſt harder and more compact than the reſt.

The Cuttle-fiſh, *Sepia*, is met with chiefly in the Mediterranean ſea, near the ſhores: The bone is often thrown on ſhore by ſtorms, and there picked up; I have ſeen ſeveral along the coaſt of the Adriatic, in travelling from Loretto by the way of Ancona, Peſaro, Rimini, *&c.* This fiſh is one of thoſe, whoſe fleſh lies bare, without any ſkin; the others of that claſs are, the *Polypus* and *Loligo*. It is furniſhed with a certain liquor of an inky blackneſs, which it is ſaid to throw out upon being purſued, and thus to eſcape or conceal itſelf by rendering the water muddy. This liquor, inſpiſſated, is ſaid to be the principal ingredient in the Indian ink uſed in drawing.

Half an ounce of the ſoft ſpongy part of Cuttle-bone, digeſted in rectified Spirit of Wine, gave ſix grains of extract, of a fiſhy ſmell, a ſaline taſte, and cryſtalline appearance. Another half ounce, digeſted and boiled with water, gave a ſcruple of extract, in colour whitiſh-brown, in taſte quite ſaline. The powder remaining after the action of both liquors appeared unaltered.

The powdered bone, ſprinkled by little and little into Spirit of Vitriol, totally diſſolved, and ſoon cryſtallized again upon the ſurface, without communicating any tinge to the liquor. The nitrous and marine acids likewiſe totally diſſolved it, without receiving any colour. The ſolution in the marine acid was in taſte extremely bitter: This acid forms indeed a bitter compound with all the animal and other abſorbent earths; but with none ſuch an intenſe bitterneſs as with Cuttle-bone. Spirit of Sal ammoniac had no effect upon this bone. Common alcaline Ley and cauſtic Ley corroded a little; the firſt acquired no tincture, the latter a yellowiſh one.

Two ounces of the powder, diſtilled in a glaſs retort in an open fire, gave over two drams of an urinous liquor, of a ſlightly volatile ſmell mixed with the common empyreumatic one; on its ſurface there was alſo a little actual empyreumatic Oil. The Caput mortuum weighed one ounce ſix drams.

I repeated the ſame experiments upon the upper hard cruſt or ſhell. Half an ounce of this yielded with rectified ſpirit four grains, and with water a ſcruple of extract: Both the extracts agreed exactly with thoſe made from the ſpongy part, except that the watery extract of the ſhell was of a darker brown colour: Both the reſidua were unchanged.

The powdered ſhell totally diſſolved in Spirit of Vitriol, tinged the menſtruum reddiſh, and ſeparated again in part in a fine white cryſtalline form. It totally diſſolved alſo in Spirit of Nitre and Spirit of Sea-ſalt, without imparting any colour. By Spirit of Sal ammoniac, it was not ſenſibly acted on. Common alcaline Ley corroded a little into flakes, without acquiring any tinge: Cauſtic Ley received from it a yellowiſh hue, but diſcovered no further action.

On diſtilling two ounces in an open fire, I obtained four ſcruples of urinous liquor, of a volatile empyreumatic ſmell, and half a ſcruple of empyreumatic Oil; the Caput mortuum weighed one ounce ſix drams and a half.

CUTTLE-BONE. It appears from this analyſis, that the difference betwixt the two ſubſtances, in regard to the principles they are compoſed of, is not very great: That the ſhell contains moſt oily matter, and conſequently that the ſpongy part is the pureſt earth and the ſtrongeſt abſorbent.

This earth is ſuppoſed to differ, medicinally, from the other animal abſorbents, in having a mild aſtringency. It is ſometimes uſed, by thoſe who caſt metals in the ſmall way, for forming a mould.

CLASS II.

Earthy parts of Animals reducible by Fire into Quick-lime.

CALCAREOUS. THIS claſs comprehends the ſhells of ſea-fiſhes; a ſubject which, by the multiplicity and diverſity of colours and figures, is both extenſive and delightful to the naturaliſt, but affords little variety to the chemiſt. All theſe ſubſtances conſiſt of the ſame calcareous earth, blended with more or leſs of the conglutinating animal principles. They burn into a Quick-lime, more acrimonious, which impregnates water with a greater degree of activity, and which, when tempered into mortar, proves more durable and more compact than the Limes made from mineral ſtones or earths (*f*). The Dutch have no other Lime for building, than calcined ſea-ſhells, particularly thoſe of Muſcles.

I. MUSCLE-SHELLS. HALF an ounce of MUSCLE-SHELLS digeſted and boiled in rectified Spirit of Wine, yielded one grain of extract, which taſted and ſmelt rancid. Another half ounce, treated with water, gave a ſcruple of a yellowiſh maſs, in taſte ſaline. The remaining powders had the ſame appearance as at firſt.

This ſhell totally diſſolved in Spirit of Vitriol, tinged it a little yellowiſh, and in great part ſeparated again from the ſolution in a white cryſtalline form. It diſſolved totally alſo in Spirit of Nitre, and almoſt totally in Spirit of Salt, without giving any colour to either: The ſmall matter that was left by the marine ſpirit, on being ſhaken up, rendered the liquor white, yellow and orange-coloured. Spirit of Sal ammoniac has no effect. Common Ley eats off a little flaky matter, and acquires a yellowiſh tinge: Cauſtic Ley becomes alſo yellowiſh, and renders the powder blackiſh underneath, and of a fine hoary whiteneſs on the upper ſurface.

From

(*f*) *Shell-lime ſtronger than Stone-lime-water.*] We have formerly ſeen that Oyſter-ſhell Lime-water acts much more powerfully on the human calculus than that of Stone-lime: Dr. Home informs us from experiment, that it is likewiſe the moſt efficacious in the bleaching of linen; that it whitens more, weakens more, and extracts more out of the cloth; that it ought to be looked upon as the moſt expeditious, but at the ſame time the moſt dangerous material for bleaching, that is yet known.

His experiments on this ſubject afforded one remarkable phænomenon .... Lime and Lime-water preſerve many animal ſubſtances in a ſound entire ſtate; but Lime and alcalies mixed together, yield a Ley which, in regard to animals, is extremely corroſive. The effects of theſe ſubſtances on linen are juſt the reverſe; Lime-water being here highly corroſive, and alcalies weakening its power in proportion to their quantity, inſomuch that he judges a mixture of one part of Lime with four of pure Alcali might be uſed in bleaching with ſafety.

From two ounces, diſtilled in a retort, were obtained two ſcruples of liquor, of a conſiderably volatile empyreumatic ſmell, with ſome drops of actual Oil ſwimming upon it: The Caput mortuum weighed one ounce ſeven drams and a ſcruple. MUSCLE-SHELLS.

Calcined Muſcle-ſhells, conſidered as a Lime, bind ſtrongly and quick. A certain phyſician preſcribed, in his Majeſty's Apotheca, a draught compoſed of calcined Muſcle-ſhells, vitriolated Tartar, Syrup of Citron-juice, decoction of Hartſhorn, and ſome ſimple waters. Accordingly the burnt ſhells and vitriolated Tartar were well rubbed together, the Syrup mixed with them, and the decoction and waters added by degrees: But inſtead of forming a liquid mixture, the powder, ſo ſoon as it was moiſtened, concreted into a maſs of a ſtony hardneſs, which required violence to get it out of the mortar.

II. OYSTER-SHELLS.

OYSTER-SHELLS contain leſs oily matter than thoſe of Muſcles. Hoffmann reports, that neither one nor the other diſcover in diſtillation any mark of Oil at all; but the firſt yield an actual Oil, and the latter ſufficient marks of one. From two ounces of Oyſter-ſhells, cleaned from the outer rough part, there aroſe half a dram of liquor, of a ſlightly volatile and empyreumatic ſmell: and in the neck of the retort there appeared ſome fine oily and ſaline ſtriæ. If the quantity of ſhells employed, both in Hoffmann's experiment and mine had been larger, we ſhould probably have had a more viſible proof that they are not deſtitute of Oil. The Caput mortuum was of a ſooty black colour, and weighed one ounce ſeven drams and a half.

Half an ounce of powdered Oyſter-ſhells yielded, with rectified ſpirit, one grain of extract, of a rancid taſte and ſmell. From the ſame quantity were obtained by water twenty-five grains of a yellowiſh maſs, to the taſte quite ſaline. The remaining powders were in appearance unaltered.

The powdered ſhell diſſolved totally in all the mineral acids, and communicated no colour to any of them; from the ſolution made in the vitriolic acid, there ſeparated a fine white cryſtalline matter. Alcaline liquors had no effect, excepting that alcaline Ley ſeemed to corrode a little of the powder, as it rendered it ſomewhat flaky.

III. MOTHER-OF-PEARL.

THE oriental PEARL-FISH has a great affinity with the common Oyſter; being a flattiſh bivalvous ſhell-fiſh, rough on the outſide, generally about the ſame ſize, though ſome are much larger, and continuing fixed upon the ſpot where it is formed. It is flatter than the Oyſter, and the internal part of the ſhell of a fine Pearl colour, with a reddiſh or greeniſh caſt, or more or leſs of a rainbow appearance. The lower ſomewhat concave ſhell is more beautiful than the upper flat one; and hence the former is that brought into Europe, for ornamental uſes, under the name of Mother-of-Pearl, *Mater Perlarum.* Both this and the common Oyſter-ſhell are compoſed of ſtrata laid regularly on one another; a new incruſtation being formed every year on the inſide of the ſhell. It ſeems to be one and the ſame juice, which regularly ſecreted forms the ſhell, and which unequally diſtributed or ſtagnating in particular parts concretes into Pearls; notwithſtanding the chemical differences obſerved in the two concretes.

MOTHER-OF-PEARL. Half an ounce of Mother-of-Pearl, reduced into powder, yielded with rectified Spirit one grain of extract, of a fishy smell, and saline taste. The same quantity, treated with water, yielded a scruple of extract, in colour yellowish-brown, in taste quite saline. The powders, remaining after the action of both menstrua, were of the same appearance as at first.

Saline liquors had the same action on Mother-of-Pearl as on other shells. All the mineral acids dissolved it, without receiving any tinge, except that the marine acid left a small portion undissolved, which when shaken up into the liquor, appeared composed of white, yellowish and reddish particles floating distinct from one another. Spirit of Sal ammoniac and caustic Ley had no effect: Plain alcaline Ley corroded a little into flakes, but acquired no colour.

Two ounces of powdered Mother-of-Pearl being distilled in a glass retort in an open fire gradually increased, there came over two scruples of an urinous liquor, which smelt a little volatile and empyreumatic: On its surface were observed some drops of an empyreumatic Oil. The Caput mortuum weighed one ounce seven drams and a scruple.

Dr. ——— reports, that if this shell be laid in whites of eggs well beat up, and set in the sun or in a warm place, and this process several times repeated, the shell will become soft enough to receive impressions; and that it recovers its hardness on being laid in water wherein Tartar has been several times boiled. I have tried the experiment, without being able to succeed. Perhaps the author has delivered it without having made trial himself, or perhaps he has concealed some particular management that may be necessary to the success.

IV. CRABS-CLAWS. THE BLACK TIPS of the claws of the common sea CRAB, *Cancer marinus*, levigated into a subtile powder, are frequently employed in medicine as an absorbent. Half an ounce of this powder yielded with rectified spirit two grains of extract, of a black colour and saline taste: With water, the same quantity yielded ten grains, in colour brownish, in taste very saline: Both the residua appeared unaltered.

Spirit of Vitriol dissolved a considerable quantity, and crystallized as with the other animal earths: Spirit of Nitre and of Sea-salt dissolved nearly the whole; and like that of Vitriol, received no colour. Spirit of Sal ammoniac dissolved a little, without acquiring any tinge: Common and caustic Ley were tinged yellow, without discovering any remarkable solution.

Four ounces of the powder, distilled in an open fire, gave over half an ounce of liquor, of an empyreumatic and slightly volatile smell, with some drops of an empyreumatic Oil upon the surface: During the distillation, there was an appearance of an actual volatile Salt, but in the progress of the operation it was dissolved and washed down by the liquor. The black Caput mortuum weighed three ounces and a half.

V. EGG-SHELLS. TO this class may be referred the SHELLS OF HENS-EGGS, and perhaps those of the eggs of other birds. Half an ounce of the Shells of Hens-eggs, cleared from the inner skin and reduced into powder, yielded with rectified Spirit of Wine, a grain and a half of solid extract, which in taste and smell was quite rancid. From the same quantity I obtained, by means of water,

water, twenty grains: This extract appeared of a yellowiſh colour, and what is pretty remarkable, proved ſaline to the taſte. The remaining powders had the ſame appearance as at firſt. EGG-SHELLS.

Among acids, Spirit of Nitre acts upon Egg-ſhells the moſt powerfully and moſt readily. An Egg, laid in Spirit of Nitre, had its ſhell entirely eaten off in two hours, the liquor continuing clear. Spirit of Salt likewiſe diſſolves nearly the whole of the ſhell, but requires ſix or eight hours: The ſolution is colourleſs; and of a bitter taſte, which thoſe made in other acids are not. Spirit of Vitriol corrodes, difficultly, nearly all the ſhell, and forms with it, as with the other animal earths, fine cryſtalline concretions of a ſaline appearance, without receiving any tinge.

Vinegar, diſtilled and undiſtilled, diſſolves the whole in about twelve hours; the ſolution is ſomewhat ſlimy and glutinous. The action of the acid may be promoted by cautiouſly taking out the Egg from time to time, and ſcraping off the ſlimy corroded matter with a fine knife. Towards the end of the proceſs, the Egg ſeems to expand, as if air, or a part of the menſtruum had penetrated through the pores of the ſkin; or perhaps from the included air dilating itſelf, on the removal of the ſolid matter which held it in confinement. The Egg thus freed from its ſhell is conſiderably ſoft, but does not admit of its figure being much altered, much leſs of being rolled out ſo ſlender as to enter a narrow-mouthed bottle, as reported in books of ſecrets: Laid in water, it becomes a little harder, but is very far from reſuming the hardneſs of the ſhell which it has loſt.

Solution of Tartar, which diſſolves, like other acids, ſundry abſorbent earths, had no effect on the ſhell of an Egg, though digeſted with a heat gradually raiſed to ebullition. Nor did alcaline liquors, as Spirit of Sal ammoniac, common Ley and cauſtic Ley, ſeem to have the leaſt action on it, except that the common Ley eat off a little flaky matter.

On diſtilling two ounces of powdered Egg-ſhells, in a glaſs-retort in an open fire, I obtained two ſcruples and a half of urinous liquor, which had a volatile empyreumatic ſmell, with ſeveral drops of empyreumatic Oil upon the ſurface; after this aroſe ten grains of volatile Salt, and one ounce ſeven drams of black coal remained behind in the retort. Hoffmann in his *Obſervationes phyſico-chemicæ*, and Boecler in his *Materia medica*, report, that Egg-ſhells yield an uncommonly large quantity of volatile Salt; but ten grains upon two ounces is very far from being a large yield.

Egg-ſhells are employed by the wine-coopers for curing Wines upon the fret: Added in a ſuitable ſmall quantity, they obtund the acidity, and render the liquor fit for drinking and ſufficiently wholſome: An over-proportion occaſions the Wine to grow in a very little time vapid, by abſorbing not only the preternatural acid, but that which is eſſential to it as a vinous liquor. For medicinal uſe, ſome previouſly calcine the ſhell: In this ſtate, it is more acrid and aſtringent than before, and imbibes water more readily and with ſome degree of ebullition. Various images and figures are formed of this calx mixed up with ſtrong Glue.

THE

THE marine productions, Coral, Coralline, and Sponge, uſually ranked among vegetables, differ greatly in their chemical analyſis from land-plants and their parts, and agree with ſubſtances of the animal kingdom (*g*). Their prevailing principle is an earth; but to what claſs this earth belongs, has not hitherto been determined.

I. CORAL. CORAL, (*Corallum*, *coralium*, *quaſi* κορη ἁλος, daughter of the ſea) is a hard ſtony ſubſtance, reſembling in figure the ſtem of a plant, divided into branches. It is of different colours, black, white, and red: The red is the ſort emphatically called Coral, as being the moſt common, and moſt valuable, and employed in the way of ornament; it is of a fine uniform red colour throughout its whole ſubſtance.

The greateſt quantities of Coral are met with in the Mediterranean ſea, as on the coaſts of Tuſcany, Sicily, Sardinia, Catalonia, Corſica, Majorca, Minorca, *&c.* It is fiſhed for by means of a large wooden croſs, furniſhed with a weight of Lead in the middle to ſink it, and with net-work between the arms, which being drawn by ropes, backwards and forwards among the rocks, entangles the Coral: Oftentimes divers are let down, to direct the ends of the arms into cavities of the rocks.

The Coral is produced upon the rock, and on different extraneous bodies in the ſea, and hangs with its branches downwards. It has no appearance of any root like vegetables; and adheres only ſuperficially, to the body on which it is formed, by a baſis which has the exact impreſſion of the part which it adheres to; a mark of its having been, at its firſt formation, in a ſoft ſtate.

When Coral is newly taken up, the ſmall protuberances on its ſurface are ſoft, and yield, on being preſſed, a milky juice, which effervesces with Spirit of Salt and with Spirit of Nitre, but not with any Alcali.

Count Marſigli has made ſome curious obſervations on this ſubject. Branches of freſh Coral being put into a veſſel of ſea-water, the protuberances, after ſtanding for ſome time, opened; and there came forth from each a fine white body, in form of a ſtar with eight rays: On taking the ſprigs out of the water, theſe white bodies immediately ſhrunk in again, and in their place appeared red protuberances as at firſt: On putting the Coral ſprigs a ſecond time in water, the protuberances opened again, and the white flowers, as he ſuppoſes them, [but more probably animalcules of the polypus kind] came forth as before. After theſe bodies had kept expanded in the water for ſome days, they contracted into yellow balls, which dropt off and fell to the bottom, and on being opened were found to contain only a glutinous matter, not any fruit or ſeed as was expected. The cortical part of the Coral had now grown ſoft, and fell off in pieces, which formed a ſoft earth like fine Red-bole. At the ſame time, a milky juice, lodged betwixt the cortical part and the inner ſubſtance

(*g*) *Agree with animal ſubſtances.*] Some late obſervations afford reaſon to believe, that theſe bodies are really animal productions; the work, and the habitation of marine polypi. See the late volumes of the philoſophical Tranſactions, and a paper by Mr. Juſſieu in the French Memoirs for the year 1742.

ſtance of the Coral; was communicated to the water, and made it putrefy; but in leſs than a month, there appeared upon the ſurface a white gelatinous ſkin, about the thickneſs of the back of a knife, and the water recovered its original ſmell and taſte. CORAL.

The cortical part which the Coral is all over coated with, is not near ſo compact and hard as the internal, and may be eaſily taken off whilſt freſh: The Coral is commonly freed from this bark before it is brought to market. The greateſt Coral trade is in Genoa and Leghorn. The ſmall ſprigs, unfit for ornamental uſes, are in the ſhops levigated into a ſubtile powder, which is given medicinally as an abſorbent and mild reſtringent.

Coral is not unfrequently imitated by artificial compoſitions; ſome of which exactly reſemble the natural in weight, hardneſs, politure, colour and appearance, are equally reduced, by ſhaving with a knife, into a fleſh-coloured powder, make the ſame grating noiſe betwixt the teeth, equally effervelce with Spirit of Nitre, and yield a like yellowiſh magma. The abuſe is beſt diſcovered by fire, the counterfeit not affording the alcaline earth which the genuine Coral does. The colouring ingredients in the artificial maſſes are Cinnabar and Minium, both which are eaſy to be diſcovered.

The natural Coral ſeems to receive its colour from Iron; for Spirit of Vitriol acquires from it a ferrugineous taſte; and on calcining the Coral, ſome ferrugineous particles are attracted by the magnet from among the aſhes.

Sixteen ounces of Coral, diſtilled in an open fire, yield commonly about ſix ſcruples and a half of a volatile urinous liquor impregnated with volatile alcaline Salt and Oil, together with two or three grains of an actual empyreumatic Oil: From the Caput mortuum, calcined, five ſcruples and a half of fixed Salt may be extracted. The quantities of theſe products vary, according as the Coral is freſher, or longer kept: Once I obtained, from ſixteen ounces, three drams of urinous ſpirit, and three drams of fixed Salt; another time, I got ſcarce two ſcruples and a half of ſpirit, and no Oil, the proportion of fixed Salt being nearly the ſame as before.

The fine red colour of Coral moved the credulity of former times to expect from it extraordinary medicinal virtues; and accordingly various ſolutions, magiſteries, Salts, and other preparations have been made from it in this view. The principal aim has been, to extract its colouring matter in the form of ſpirituous tincture: Red tinctures have indeed been prepared with it, but they owed their colour to the menſtruum or to other ingredients; the colour of the liquor turning out the ſame, when white Coral is uſed as when the red, and even when no Coral is uſed at all.

It is obſervable however that in ſome of theſe proceſſes the Coral loſes its colour. One of the tinctures is prepared by diſſolving a pound of Sugar in a little water, adding half a pound of Wax, boiling a pound of Coral in this mixture till it loſes its redneſs, and then digeſting the Wax and Sugar in Spirit of Wine. The Coral, deprived of its colour by this proceſs, is found to be in other reſpects unaltered, and to have loſt nothing of its weight. I have not been able to reſtore its colour, by baking it in a loaf of bread, hanging it in a privy, or the other means recommended by authors for recovering and calling forth its latent redneſs.

CORAL. Lemery relates, that by treating red Coral with white Wax, and afterwards digeſting the Wax with tartarized Spirit of Wine, he has transferred the tincture of the Coral out of the Wax into the Spirit. On repeating this experiment, I obtained no tincture, but only a quite thick ſolution of the Wax, though trial was made with both kinds of tartarized Spirit of Wine, that prepared by ſolution, and that by diſtillation.

Among all the tinctures of Coral, Langelott's (deſcribed in the *Ephemerides naturæ curioſorum*) is the moſt remarkable, though it is at the ſame time not a little ſuſpicious. Pieces of red Coral, digeſted for a month with a perfectly white diſtilled Oil, are ſaid to have become redder and ſofter; and on continuing the heat, to have been reſolved into a deep red Mucilage (*Mucilago rubicundiſſima*); the Oil remaining colourleſs, and not miſcible with the Mucilage. This Mucilage, ſeparated from the Oil, and digeſted a little in tartarized Spirit of Wine, is ſaid to have been reſolved into a deep red tincture.

II. CORALLINE. CORALLINE, *Corallina*, (ſo called from its having been firſt obſerved upon Coral) is a branched ſubſtance, reſembling ſome of the moſſes, compoſed of a number of articulations, found adhering to different bodies, in the Mediterranean and other ſeas. It is of various colours, reddiſh, yellowiſh, green, greeniſh and whitiſh; among which the green and whitiſh are the moſt common. It is friable betwixt the fingers, gritty like ſand betwixt the teeth, of a ſomewhat ſaline taſte, and a ſtrong fiſhy ſmell. Phyſicians ſuppoſe it to be anthelmintic.

Half an ounce of powdered Coralline, boiled with water, gave two ſcruples of extract; and afterwards with rectified ſpirit, ten grains: Spirit, applied at firſt, extracted from the ſame quantity thirty grains; and water, afterwards, juſt as much: The earthy reſiduum weighed, in the firſt caſe three drams ten grains, in the latter only three drams. Spirit of Nitre diſſolved a conſiderable portion of the Coralline. On diſtillation in an open fire, there aroſe an urinous and empyreumatic liquor.

III. SPONGE. SPONGE is a ſoft, tough, compreſſible ſubſtance, full of pores, found, like the two foregoing, adhering to different bodies in the ſea. It is of various ſizes and colours, yellowiſh-white, yellow, reddiſh-yellow, brown, greyiſh, *&c.* The middling pieces, of a yellowiſh colour, with ſmall pores, free from ſtones, ſhells, *&c.* are the beſt.

The great compreſſibility of Sponge, and its property of ſoaking up water, makes it uſeful, mechanically, on many occaſions. From the ſame property, it is ſometimes employed by the ſurgeons for dilating the orifices of wounds and ulcers: A piece of Sponge, dipt in melted Wax, may be preſſed into a very little compaſs, and is prevented from expanding again by the induration of the Wax; a piece thus prepared, put into the orifice, imbibes the moiſture of the part, and is proportionably dilated.

Burnt Sponge is ſometimes employed in powders for cleaning the teeth, and likewiſe given by phyſicians in ſcrophulous diſorders. It muſt be obſerved that in this ſtate, it is a ſubſtance of an entirely different kind from the crude Sponge. See page 501.

Half

Half an ounce of choice Sponge, cut in ſmall pieces, being digeſted and boiled in water, and afterwards in rectified ſpirit, the watery decoctions left on being evaporated thirty grains of extract, and the ſpirituous three grains; three drams twenty-ſeven grains remaining undiſſolved. On inverting the order of applying the two menſtrua, the proportions turned out ſomewhat different: For the ſame quantity being treated firſt with ſpirit and then with water, I obtained of ſpirituous extract five grains, and of watery twenty-five; the reſiduum weighing three drams and a half. SPONGE.

The watery extracts taſted ſaline, and ſmelt of the Sponge: The ſpirituous had a ſweet kind of ſmell, and a ſlightly ſaline taſte; that made by ſpirit after water had a degree of bitterneſs, which the others diſcovered nothing of. In evaporating the tincture made by ſpirit at firſt, the matter which the ſpirit had diſſolved, began to ſeparate, and formed a yellowiſh-green tranſparent ſlime upon the ſurface; which in the progreſs of the evaporation, fell to the bottom, and conſtituted the extract. In diſtillation, the ſpirit aroſe unaltered; but the diſtilled water had a ſtrong ſmell like that of ſea-weeds or freſh Coralline.

All the mineral acids totally diſſolved Sponge, by the aſſiſtance of a gentle heat, but with different degrees of facility: The nitrous acid diſſolved it moſt readily, the vitriolic more ſlowly, and the marine the moſt ſlowly of the three. Spirit of Sal ammoniac, Oil of Tartar per deliquium, and Lime-water, had little or no effect, though the Sponge was boiled with the two laſt, for a conſiderable time.

Sponge, analyſed by fire, gives indubitable proofs of an animal nature, which is much more ſtrongly marked in this ſubſtance than in the Corals or Corallines. Laid on burning coals, it yields the ſame fetid ſmell that horns, bones or feathers do: Diſtilled in cloſe veſſels, by a ſtrong fire, it gives over a larger quantity of a concrete volatile Salt, than thoſe bodies themſelves, agreeing in this reſpect with Silk.

Mr. Geoffroy informs us, in the Memoirs of the French Academy of Sciences, that ſixteen ounces of Sponge were reduced by drying to eleven ounces; that from theſe he obtained one ounce four drams and a half of phlegm, one ounce and a half of urinous ſpirit, one ounce four drams and a half of volatile Salt, and half an ounce of empyreumatic Oil; and that the Caput mortuum, calcined and elixated with water, gave half an ounce of a fixed Salt, not purely alcaline, but of the marine kind.

Count Marſigli diſtilled five ounces of Sponge, and obtained from this quantity, half an ounce of phlegm, one ounce two drams of firſt ſpirit, ſeven drams of a ſecond oily ſpirit, two drams ten grains of volatile Salt, and thirty-ſeven grains of fixed Salt: See his *Hiſtoire phyſique de la mer*, *Partie* iv.

I ſubmitted to the ſame operation four ounces of Sponge, well waſhed and dried and cut in pieces. There aroſe two ounces and a half of liquor phlegmatic and urinous, one dram of empyreumatic Oil, and ſeven drams of volatile Salt. The Caput mortuum, which weighed one ounce ſix drams, being incinerated in the open air, and elixated with water; the Ley, on ſtanding for ſome time, depoſited twenty-ſeven grains of a cryſtalline Salt, and the remaining liquor, inſpiſſated, left eighteen grains more of ſaline matter. The pure earth weighed two drams two ſcruples and five grains.

SECT. VII.

HAIRS, FEATHERS, &c.

HAIR, &c. THESE kinds of ſubſtances give out very little to watery or to ſpirituous menſtrua; but are powerfully acted upon by acid and by alcaline liquors aſſiſted by a boiling heat. Hair diſſolves totally in Spirit of Nitre, into a yellow liquor, which if ſaturated with the Hair, in a boiling heat, depoſites a part in cooling, in form of a whitiſh mucilaginous ſubſtance. Cauſtic alcaline Ley likewiſe diſſolves, by a boiling heat, Hair, Feathers, and Wool. How theſe bodies may be dyed of a variety of colours, we have formerly ſeen under the heads of the colouring materials. I ſhall here relate the analytical experiments I have made upon them by fire: The quantity employed in each of theſe experiments was ſixteen ounces.

Sixteen ounces of human Hair, diſtilled with a fire gradually increaſed, gave over in all eleven ounces and five drams. On ſeparating the ſeveral diſtilled matters from one another, I had five ounces ſix drams of urinous ſpirit; two ounces one dram of volatile Salt; and three ounces ſix drams of empyreumatic Oil. The Caput mortuum weighed four ounces three drams, and on being calcined in an open fire loſt five drams: From the white aſhes I extracted, by elixation with water, twenty-one grains of a fixed Salt.

From ſixteen ounces of Cows-hair there diſtilled eleven ounces and a half: The urinous ſpirit weighed ſeven ounces four drams; the volatile Salt one ounce ſix drams; and the empyreumatic Oil two ounces two drams. There remained in the bottom of the diſtilling veſſel four ounces four drams of a black coal; which in calcination to whiteneſs loſt four drams. From the white calx were extracted twenty-ſeven grains of ſaline matter.

The total of the diſtilled matter from Horſes hair was two ounces leſs than from Cows hair. There were of urinous ſpirit ſix ounces four drams, of concrete volatile Salt one ounce ſix drams, and of empyreumatic Oil one ounce two drams. The Caput mortuum weighed five ounces ſeven drams, and loſt ſeven drams on being calcined: On elixation it yielded ſix grains of fixed ſaline matter.

Hogs briſtles yielded more volatile Salt (the moſt important product in theſe kinds of experiments) than the Hair of Cows and Horſes, but a little leſs than human Hair. From ſixteen ounces there aroſe in all eleven ounces and a half, and the remaining coal weighed four ounces and a half. The urinous ſpirit amounted

amounted to seven ounces and a half, and the Salt to two ounces; the quantity of Oil was the same with that of the Salt. The Caput mortuum weighed, when calcined to whiteness, three ounces six drams; and gave out to water twenty-four grains of fixed Salt. HAIR, &c.

Sheeps Wool gave just as much volatile Salt as the Hogs Bristles, but a little less spirit, and a little more Oil. The whole of the distilled matter weighed, as in the former experiment, eleven ounces and a half; the spirit, separated from the rest, weighed seven ounces, and the Oil two ounces and a half. The quantity of Caput mortuum was three ounces six drams, which lost in calcination only two drams. From the calx were obtained by water thirty grains of fixed saline matter.

Feathers may not improperly be ranked in this class of bodies——The Feathers of poultry yielded more volatile Salt than any of the substances abovementioned. From sixteen ounces there arose in all nine ounces and six drams; from which, by the usual method of separation, I had six ounces two drams of spirit, two ounces two drams of Salt, and one ounce two drams of Oil. The Caput mortuum weighed six ounces and a half, and lost in calcination just an ounce. Twenty-six grains of saline matter were elixated from the calx.

Of all the animal substances I have examined, there are very few that yield near so much volatile Salt as Silk does. From sixteen ounces of Silk there arose in distillation nine ounces of mixed matter: On separating the distilled matters, I had four ounces two drams of urinous spirit, three ounces six drams of volatile Salt, and one ounce of empyreumatic Oil. The Caput mortuum weighed seven ounces, and lost an ounce on being calcined to whiteness. By elixating the calx, I obtained forty grains of fixed saline matter.

It may here be observed, that as all these insipid substances, possessed of no medicinal powers, yield nevertheless a notable quantity of volatile Salt, and even more than some of those that are medicinally the most active; it follows, that the theory cannot be just, which makes the medicinal activity of animal matters to depend upon the volatile Salt producible from them, and ascribes particular virtues to particular bodies in consequence of their affording even an inconsiderable quantity of this Salt. If Cochineal for instance yields a volatile Salt on being analysed by fire, can this be any foundation for its use as a medicine, when Hair, and Wool, and Feathers, yield twice or thrice as much.

TO the foregoing analyses it may be proper to subjoin that of Leather. The several kinds of Leather are the skins of different animals, differently prepared; macerated for a length of time with Lime and water, to promote the separation of the Hair or Wool and of the fat and fleshy parts; then tanned by maceration with certain astringent substances, particularly Oak-bark (*h*); and afterwards LEATHER.

(*h*) *Tanned by Oak-bark.*] The use of Oak-bark in tanning depends wholly upon its astringent quality, by which it contracts the fibres of the skin, makes the texture more

LEATHER. afterwards ſuppled and ſtained by oily and certain colouring drugs. Both ſkins and prepared Leather give out, on being boiled with water, a large quantity of a ſtrong Glue; in which reſpect they differ conſiderably from the ſubſtances above-mentioned, to which, in their analyſis by fire, they bear a great reſemblance.

From ſixteen ounces of cuttings of Leather, there diſtilled in all nine ounces and a half: The urinous ſpirit weighed ſix ounces and a half; the volatile Salt one ounce ſix drams; and the empyreumatic Oil, one ounce two drams. The Caput mortuum weighed five ounces ſeven drams, and when calcined to whiteneſs five ounces; the ſaline matter extracted from it, ſix grains.

SECT. VIII.

ANIMAL FLESH.

FLESH. THE nutritious matter of animal Fleſh is a ſubſtance of the gelatinous kind; which water by long boiling diſſolves and extracts, from ſome ſorts of Fleſh more readily and more completely than from others. If the coction is performed in cloſe veſſels, and the liquor ſkilfully exhaled to a due conſiſtence, it yields a ſolid extract, which on ſome occaſions may be a ſerviceable preparation; as when thoroughly dried it keeps well, and may be again diſſolved by warm water into a liquor approaching in quality to a freſh decoction of the animal ſubject.

I analyſed, by diſtillation in an open fire, dry Vipers Fleſh from Italy, and freſh Beef and Fiſh: And to ſee how far blood differs from Fleſh in the ſubſtances into which it is by this proceſs reſoluble, I made a like analyſis of Ox's blood; employing in all theſe experiments, as in thoſe of the foregoing ſection, ſixteen ounces of each of the ſubjects.

Sixteen ounces of dry Vipers gave over in all eight ounces and ſix drams: The urinous ſpirit weighed four ounces and five drams; the volatile Salt two ounces two drams; and the empyreumatic Oil one ounce ſeven drams. The remaining black coal weighed ſix ounces ſeven drams and a half; and when calcined to whiteneſs, ſix ounces three drams. From the white calx were extracted by water forty-eight grains of fixed Salt.

The freſh Beef, as containing its native moiſture, yielded a much larger quantity of phlegmatic ſpirit, and a ſmaller one of concrete Salt. The whole diſtilled

more denſe and cloſe, and the Leather of conſequence leſs pervious to water and more durable. There are many other vegetable ſubſtances, which produce the ſame effects, and which might be ſubſtituted to Oak-bark: All the vegetable aſtringents, that give out their aſtringency to water or ſtrike a black colour with ſolution of Chalybeate Vitriol, are fit for this uſe, more or leſs ſo in proportion to their degree of aſtringency.

distilled matter weighed fourteen ounces two drams and a half; of which the spirit made up thirteen ounces five drams and a half, the volatile Salt only one dram, and the empyreumatic Oil four drams. The Caput mortuum weighed one ounce four drams and a half, lost in calcination one dram and a half, and gave out to water eighteen grains of saline matter. FLESH.

The total quantity of distilled matter from the Fish was exactly the same as from the Beef, but the volatile Salt was in larger proportion: Of spirit I had thirteen ounces two drams and a half, of concrete Salt five drams, and of Oil three drams. The Caput mortuum weighed, as that of the Beef, one ounce four drams and a half, and lost a dram and a half in calcination: The saline matter, extracted from the calx by elixation, amounted to twenty-five grains. FISH.

The Ox blood I inspissated to dryness, previously to the distillation. Sixteen ounces of fresh Blood were reduced by the evaporation to three ounces and a half; and the vapour that exhaled, being caught, was found to be mere water——The three ounces and a half of dried Blood being committed to distillation in an open fire, there arose two ounces and a half, and one ounce remained. Of urinous spirit I had one ounce, of concrete Salt six drams, and of Oil six drams. The Caput mortuum lost in calcination one dram; and water extracted from the calx ten grains of saline matter (*i*). BLOOD.

HUMAN bodies embalmed, called MUMMIES (a word said to be of oriental origin, and to signify *pissasphaltum* or Bitumen mixed with Pitch) have been brought MUMMY.

(*i*) *Further experiments on Blood.*] Recent Blood is equably fluid, and in taste somewhat saline. Viewed by a microscope, it appears composed of numerous red globules swimming in a transparent fluid.

On standing for a little time, it separates into a thick *crassamentum*, and fluid *serum*. By agitation, it continues fluid: A consistent polypous matter adheres to the stirrer, which by repeated ablution with water, becomes white.

Received from the vein in warm water, it deposites a quantity of transparent filamentous matter, the red portion continuing dissolved in the water. On evaporating the fluid, a red powdery substance is left.

It congeals by frost, and becomes fluid again by warmth: After the liquefaction it quickly putrefies. Fluid and florid Blood, exposed to a temperate air, putrefies sooner than such as is more dense.

Inspissated to dryness, it leaves a dark-coloured mass, amounting at a medium to about one fourth the weight of the Blood, of a dark colour, and a bitter saline taste, easily inflammable, burning with a bluish flame. The exsiccated Blood is not dissoluble in acid or in alcaline liquors, but gives some tincture to water and to Spirit of Wine, and is more powerfully acted upon by dulcified Spirit of Nitre.

Recent Blood is coagulated by the mineral acids, and by most of the combinations of them with earthy and metallic bodies. With vegetable acids and with solutions of neutral Salts, it mingles equably without coagulation. Alcalies both fixed and volatile, render it more fluid, and preserve it from coagulating.

The serum of Blood is more saline than the *crassamentum*, and does not so speedily putrefy. It freezes somewhat more difficultly than pure water, and its aqueous part evaporates, by a gentle warmth, somewhat more readily, leaving about one twelfth the weight of the serum of a solid yellowish pellucid matter. Exposed to a heat a little greater than that of the human body, it coagulates into a solid mass, without any considerable evaporation. Both this coagulum, and the inspissated serum, are readily inflammable in the fire, not dissoluble in water or in Spirit of Wine, in acid or in alcaline liquors.

MUMMY. brought from Egypt, counterfeited in Europe, and recommended by the ſuperſtition of former times for medicinal uſes. Some diſpenſatories have received Mummy as an officinal; and many who have diſclaimed the uſe of it as a preparation of perhaps diſeaſed human fleſh, have nevertheleſs been prejudiced in its favour by the balſamic and aromatic ingredients with which it is prepared. How ridiculous a pretence! Have we not balſams and aromatics in abundance, free from the diſguſtful mixture which makes, or is ſuppoſed to make the baſis of Mummy? And how much more prudent is it to uſe known ſubſtances, mixed in known proportions, than an unknown medley, of which perhaps we ſhall not meet with two parcels alike?

The Mummy I examined, contained a large proportion of earthy matter, and of a bituminous one of the Aſphaltum kind. Four ounces diſtilled in an open fire, yielded three drams of phlegm, two drams and a half of urinous ſpirit, and at leaſt nine drams of a thick Oil of the conſiſtence of balſam: The Caput mortuum, calcined and elixated, yielded one dram of fixed Salt—— From four ounces of the ſame Mummy I obtained, by Spirit of Wine, two ounces and two drams of reſinous extract: From the remainder I obtained, by water, five ſcruples of a gummy extract; one ounce and ſix drams remaining undiſſolved——Four ounces of the ſame Mummy, treated firſt with water, gave five drams and a ſcruple of gummy extract; and afterwards with rectified ſpirit one ounce three drams and a ſcruple of a reſinous one; the indiſſoluble part amounting to two ounces all but two ſcruples——Spirit of Wine, diſtilled over from the Mummy, received little alteration in its ſmell or taſte; water, a conſiderable one.

SECT. IX.

Gelatinous ANIMAL SUBSTANCES.

JELLIES. THE ſolid parts of animals, whether horny, bony, or earthy, contain more or leſs of gelatinous matter; which is extracted by long boiling in water, and recovered in a ſolid form by evaporating the decoction. It is chiefly on this gelatinous principle, that their ſolidity and firmneſs depend; for all of them, by the ſeparation of it, are rendered friable.

The earthy bodies contain the leaſt of this conglutinating matter; the harder bones, more; and the more flexible horns, more than any of theſe. The ſkins of animals generally contain more than any of the other parts.

The oily principle of the ſubject either makes an eſſential ingredient in the compoſition of the jelly, or is extracted along with it by the water, being by its mediation rendered ſoluble in water, in the ſame manner as the Oils and Reſins of vegetables are by their Gums or Mucilages. For the jelly extracted from bones, *&c.* detonates very ſtrongly with Nitre, and yields in diſtillation a large quantity of Oil and volatile Salt; whilſt the remaining bone detonates very

very languidly, and affords little or no Salt or Oil. It ſeems to be the gelatinous matter, univerſally, that is the direct matrix or ſeat of thoſe particles of which the volatile Salt is formed. JELLIES.

From two ounces of ordinary Glue, that is, the jelly of Mutton bones (*k*), I obtained, by diſtillation in an open fire, two drams of a colourleſs phlegmatic liquor, of a ſopy ſmell, two drams of a volatile urinous ſpirit, and two drams and a half of empyreumatic Oil.

The Glues or Jellies, extracted from different animal ſubſtances, differ notably from one another, not only in quantity, but in their degree of tenacity and purity. The greateſt difference is betwixt thoſe of water and of land animals. The Glue of fiſhes is in general much the hardeſt, and leaſt eaſily penetrated by water; that of many kinds of ſea-fiſhes acquires a hardneſs approaching to that of ſtone.

THE fine Glue called ICHTHYOCOLLA, Iſinglaſs, Fiſh-glue, is extracted from a large fiſh, which is common in the Ruſſian ſeas, and often comes up into large rivers, as the Wolga, the Danube and others, in Ruſſia, Walachia, Hungary, *&c.* Many waggon loads of this fiſh are brought to Vienna, in autumn, every Friday afternoon, and ſold next morning by the pound. I have never ſeen any there above nine or ten feet long, though they are commonly deſcribed as being twenty-four feet in length; nor is the mouth remarkably wide; nor have they any of the ſcales repreſented in Pomet's figure: The Cachelot or Spermaceti-Whale of that author reſembles them more (excepting in the teeth and the organs for ſpouting) than the figure which he gives as that of the Ichthyocolla fiſh. They have no bones, nor any griſtles, except a few about the head. FISH-GLUE.

Ichthyocolla is prepared only in Muſcovy. It is ſaid to be made from the ſkin, tail, fins, ſtomach, inteſtines and bladder of the fiſh; by boiling or digeſting them in water, ſtraining off the liquor, evaporating it to a due conſiſtence, then pouring the matter upon a plate rubbed with Oil or Greaſe to prevent its adhering, and cutting the cake into ſlices, which are twiſted or coiled up while ſoft into different forms, and afterwards thoroughly dried. The thin, clear, white pieces are the beſt: The large thick ones are commonly moiſt and fetid in the inſide.

Ichthyocolla diſſolves totally in water, excepting a ſmall quantity of impure or filamentous matter, which had been caſually mingled or paſſed through the coarſe ſtrainer with it. For ſome purpoſes, it is directed to be diſſolved in Spirit of Wine: Rectified ſpirit does not act upon it in the leaſt; proof-ſpirit diſſolves it by virtue of its phlegmatic part.

By

(*k*) *Glue.*] Bones and ſinews, ſaid to be uſed for this purpoſe in Germany, France, *&c.* do not afford near ſo ſtrong a Glue as ſkins; from which laſt the Engliſh Glue is prepared by the tanners. The cuttings or parings are ſteeped and waſhed with water; then boiled with freſh water till the liquor begins to grow thick, when it is ſtrained through baſkets, ſuffered to ſettle, and then further evaporated, till on being poured into flat moulds it concretes in cooling into ſolid cakes, which are cut in pieces, and dried on a kind of net.

FISH-GLUE. By diſtillation in an open fire I obtained, from eight ounces of Ichthyocolla, four ounces two drams of urinous ſpirit, half an ounce of concrete volatile Salt, an ounce and a half of empyreumatic Oil, half a ſcruple of fixed Salt, and nine drams of earth.

Ichthyocolla is employed chiefly for œconomical and mechanic uſes, as a fine Glue, for Mouth-glue, for joining cracked Porcelane and Glaſs, for ſtiffening Silk and Gawze, for making artificial Pearls, *&c.* but more particularly for fining turbid Wines, in which buſineſs the greateſt quantities of it are conſumed. For this purpoſe, ſome throw an entire piece, about a quarter of an ounce, into a Wine caſk; by degrees the Glue diſſolves, and forms a ſkin upon the ſurface, which at length ſubſiding, carries down with it the feculent matter that floated in the Wine: Others previouſly diſſolve the Iſinglaſs, and having boiled it down to a ſlimy conſiſtence, mix it with the liquor, roll the caſk ſtrongly about, and then ſuffer it to ſtand to ſettle.

That Wines thus clarified, are quite wholeſome, is a little queſtionable. It is certain, that a portion of the Iſinglaſs remains diſſolved in them; and though this ſhould ſeem to be no unſalutary ingredient, as being oftentimes uſed medicinally for obtunding and incraſſating acrimonious thin humours, and reſtraining immoderate excretions, yet it is not perhaps in Wines entirely innocent. I have been aſſured by a gentleman of good experience in theſe matters, (Purveyor of the cellar to his Britannic Majeſty) that Wines fined with Iſinglaſs, eſpecially if drank a little too ſoon, occaſion ſeveral ill conſequences. I was once myſelf, after drinking only a few ounces of Sack which had thus been clarified but had not ſettled quite fine, ſeized in a little time with a ſickneſs and vomiting, followed by ſuch a vertigo that I could not ſtand upright for a minute together; the giddineſs continued, with a nauſea and want of appetite, for ſeveral days.

EGGS. WHITES OF EGGS may be ranked among gelatinous ſubſtances, as poſſeſſing their viſcous glutinous quality, ſo as to be uſed in cements for Glaſs and Earthen-ware, though they differ remarkably from the other bodies of this kind, (at leaſt, from thoſe extracted from the ſolid parts of animals,) in being not diſſolved, but hardened by boiling water. Hence their uſe for clarifying boiling liquors: Beat up into a froth, and mixed with the liquor, they unite with and entangle the impure matters that floated in it, and preſently growing hard by the heat, carry them up to the ſurface in form of ſcum no longer diſſoluble in the liquid.

Whites of new laid Eggs, expoſed to the ſun in ſummer for ſome weeks, in a large glaſs veſſel, gradually loſt their fluidity, and became at length quite dry and hard: In this ſtate, they did not ill reſemble in colour, conſiſtence and tranſparency, yellowiſh gum Arabic or fine Amber: They ſtill diſſolved in cold water, and formed a viſcous fluid as at firſt. Ten drams were reduced by the drying to two drams and a half; in another trial, the ſame quantity weighed when dry two drams two ſcruples.

When the white is hardened by boiling, it ſtill loſes a very large proportion of its weight on being dried: A white of an Egg boiled hard, weighing ſix drams twenty-five grains, weighed when dry only fifty-five grains: Another, which

which weighed ſix drams forty-ſeven grains, was diminiſhed to fifty-two grains. EGGS.

White of Eggs in its liquid ſtate, expoſed to a gentle warmth, grows by degrees thinner and thinner, in no long time putrefies, and when putrefied greatly reſembles urine both in its appearance and qualities.

When beaten up into froth and ſuffered to ſettle, it divides into two parts; a thick one which falls to the bottom, and a thin fluid which floats above.

Mixed with rectified Spirit of Wine, it is coagulated or hardened, nearly in the ſame manner as by heat; this effect ſeems to ſucceed beſt, when the two liquids are taken in equal quantities. It mingles uniformly with cold water, or ſuch as is juſt warm; and with Vinegar and other vegetable acids.

By the acids of the mineral kingdom it is coagulated, but ſomewhat differently by the different acids. Spirit of Nitre acts on it the moſt powerfully: When gradually mixed with this, it becomes firſt white, then of a Sulphur-yellow colour, thickens more and more, ſwells up into bliſters, and at laſt grows quite tenacious and conſiſtent, ſo as not to run out upon inverting the glaſs. With Spirit of Salt, it turns firſt white and curdly; on ſhaking the mixture, it looks much like ſkimmed Milk. Oil of Vitriol renders it ſlimy and tenacious; but on ſtanding, the mixture grows thin and fluid, and at the ſame time yellow.

Solutions of Alum, white Vitriol, and green Vitriol, mingle equably with white of Eggs, excepting that a very ſmall portion of flaky matter ſeparates: Solution of blue Vitriol partly coagulates and renders it ſlimy: By ſtrong agitation continued for ſome time, all theſe mixtures in ſome degree coagulate.

Cauſtic Ley mixed with white of Eggs ſeemed at firſt to coagulate it, eſpecially when the white was previouſly beat up into froth; but on ſtanding for a little time, the whole became fluid again. Common Ley and Spirit of Sal ammoniac mingled without coagulation, only a little flaky matter appearing at laſt to float about in the liquor.

Sixteen ounces of whites of Eggs, diſtilled in a glaſs retort, at firſt in a ſand-heat and afterwards in an open fire very gradually increaſed, gave over thirteen ounces ſix drams and two ſcruples of phlegm which had neither ſmell nor taſte; five drams and half a ſcruple of a volatile urinous empyreumatic ſpirit; three drams of fetid Oil; and three drams and a half of volatile Salt: The Caput mortuum was black, ſpongy, bliſtery, and very light, and weighed five drams twenty grains.

I diſtilled alſo in the ſame manner two ounces of the whites boiled hard: There aroſe two drams and a half of inodorous and inſipid phlegm, half an ounce of volatile urinous ſpirit, thirty-five grains of empyreumatic Oil, and fifteen grains of volatile Salt: The remaining coal weighed two ſcruples: The Caput mortuum calcined white, was reduced to an inſipid earth, entirely deſtitute of Salt.

It is obſervable that boiled whites of Eggs partly liquefy on being kept in a moiſt cellar; and that powdered Gummy-reſins, as Myrrh, incloſed in the white, partly diſſolve or deliquiate along with it.

It is commonly ſuppoſed, that the pure Reſins alſo, as Maſtich and Benzoine, are diſſoluble in the ſame manner; and ſeveral preparations of this

EGGS. kind have been kept in the ſhops for medicinal uſe. But experiment has ſhewn that theſe *Oils per deliquium*, as they are called, receive no impregnation from the pure Reſins; that when Gummy-reſins are uſed, it is ſtrictly only the gummy part of the drug that is diſſolved by the aqueous liquid afforded by the Egg; and that by the mediation of the Gum, a portion of the Reſin is rendered ſoluble in this liquid as in common water. All that deliquiates with the white of Egg, will diſſolve at leaſt equally in ſimple water.

YOLK of EGGS. YOLKS of Eggs mingle uniformly with water, but on ſtanding ſeparate again and fall to the bottom: Mixed with Oils, Balſams, Reſins, or animal Fats, they render theſe alſo diſſoluble in water.

They contract no union with rectified Spirit of Wine, howevever agitated with it, but are in ſome meaſure coagulated or thickened.

Spirit of Vitriol and Spirit of Salt coagulate them into a butyraceous conſiſtence; Spirit of Nitre renders them ſlimy and gluey; Vinegar and alcaline Ley diſſolve or dilute them; Spirit of Sal ammoniac and cauſtic Ley thicken them, with this difference, that the mixture with the former grows thinner on ſtanding, whilſt that with the latter continues longer thick.

Yolk of Eggs, dried, does not become tranſparent and horny like the white, but opake and hard: Nor does it loſe near ſo much in the exſiccation; a boiled yolk, weighing four drams thirty-ſix grains, was reduced only to two drams thirty grains. An expreſſed Oil is obtained from the hard-boiled yolks, by beating them ſmall, keeping them ſtirring over a gentle fire till the ſuperfluous humidity is evaporated, and then committing them to a warm preſs.

Sixteen ounces of freſh yolks, diſtilled in a glaſs retort with a well graduated fire, gave over five ounces of phlegm which had no ſmell or taſte, two ounces and a half of a very ſlightly empyreumatic phlegm, one ounce ſix drams of a volatile empyreumatic ſpirit, one dram of a thin empyreumatic Oil, and five ounces half a dram of a thicker, groſſer, heavier and darker-coloured Oil: The Caput mortuum was black, compact and ponderous; and weighed an ounce and a half.

From two ounces of yolks boiled hard, there aroſe two drams of inſipid and inodorous phlegm, ſeven drams of empyreumatic phlegm, a ſcruple of volatile ſpirit, and five drams ten grains of empyreumatic Oil: The Caput mortuum weighed a dram and a half, and in appearance reſembled the foregoing. In both theſe diſtillations, a little volatile Salt begun to concrete about the ſides, but the liquor that followed, diſſolved and waſhed it down.

EGGS. OF an Egg which entire weighed 960 grains, the white amounted to 587 grains, the yolk to 249, and the ſhell with its ſkin to 124: Of another Egg, weighing 1015, the white weighed 640, the yolk 250, and the ſhell 125.

An Egg weighing 800 grains loſt, in being boiled hard, 20 grains. In keeping there is alſo a ſenſible diminution of weight; a part of the ſubſtance of the Egg tranſpiring through the pores of the ſhell: When a conſiderable vacuity is thus formed within the ſhell, the Egg begins to putrefy.

Eggs are commonly preſerved by packing them up cloſe in bran, ſaw-duſt, or other like ſubſtances. I kept one in ſalt-water from May to November;

and notwithſtanding the warmth of the ſeaſon, and that of a fire occaſionally, it continued perfectly ſweet; but the yolk was a little harder than that of a freſh Egg, and the white had received a ſlight ſaltiſh taſte, a proof of the poroſity of the ſhell (*l*). EGGS.

SECT.

(*l*) *Eggs---perſpiration*, &c.] Mr. de Reaumur has diſcovered that Eggs may be preſerved perfectly ſweet for years, by rubbing them, as ſoon as laid, with fats, oils, or other unctuous ſubſtances, which by preventing their perſpiration prevent their corruption. See his *Hiſtory of Inſects*, vol. 2. the *Memoirs of the French Academy of Sciences*, for the year 1735, and his *Practice of the art of hatching and bringing up domeſtic Birds*. From ſome experiments I have made on this ſubject it appears, that ſolid fats impede the Perſpiration greatly, but ſoft Fats and Oils not near ſo much. The principal of theſe experiments are as follows,

New laid Eggs,	*Perſpired in three months.*
Steeped twenty hours in rectified Spirit of Wine, then hung up in a dry room -	$\frac{1}{9}$
Kept in bran - - -	$\frac{1}{10}$
Kept in ſand - - - - -	$\frac{1}{12}$
Dipt in Oil, and kept in a Tin-box cloſely covered -	$\frac{1}{90}$
Dipt in melted fat, and kept in bran - - - - -	$\frac{1}{274}$
Kept immerſed in rectified Spirit of Wine - - -	*Nothing.*

THE author above-mentioned obſerves, in his treatiſes of hatching and bringing up domeſtic fowls, that Eggs perſpire in incubation between one ſixth and one fifth of their fluid contents; and that when perſpiration is prevented by unctuous ſubſtances, the Egg produces no embryo, and continues ſweet through the whole proceſs of incubation.

It may be added, that too copious a perſpiration, though the heat be no greater than under the hen, deſtroys the embryo; and that this is the principal cauſe of the ill ſucceſs complained of by thoſe who have attempted the artificial hatching of birds in England.

Thoſe who have employed for this purpoſe ovens warmed by culinary fire, have been ſolicitous only, with Mr. de Reaumur, about keeping the *heat* within proper limits, or as nearly as poſſible to that of the human body, marked 32 on Reaumur's thermometer, and 95 or 96 on Fahrenheit's . . . I had a ſmall oven, ſupplied with warm air from an athanor furnace in which a conſtant fire was kept up for other purpoſes: I contrived for it a regulating thermometer, which, as often as the heat exceeded but a very little that of the human body, ſtopt the aperture by which the warm air was admitted; and which, as often as the heat fell a little below the human, opened it again, ſo as to let in more warm air. A more equable or favourable heat could not be wiſhed for: The chickens neverthelefs periſhed in the ſhell, and not a ſingle one lived to the time of hatching. After many fruitleſs repetitions of the experiment, an exceſs of perſpiration occurred as the moſt probable cauſe of the failure: Accordingly a quantity of Eggs was weighed from day to day, both in the oven and under a hen: Thoſe in the oven loſt daily about $\frac{1}{12}$ of their weight, and thoſe under the hen only $\frac{1}{130}$.

Mr. Cederhielm, (in a paper on the artificial hatching of Eggs, in the Swediſh Tranſactions for the year 1748) finds that a degree of moiſture is neceſſary as well as heat. He obſerves, that the hen, beſides her natural perſpiration, often waſhes herſelf in water, and goes immediately to cover her Eggs. Hence he was led to moiſten his egg-boxes every day.

Reaumur's principal experiments were made in caſks ſet in hot-beds of dung; the egg-baſkets being ſupported at proper heights in the cask, a thermometer placed commodiouſly to be conſulted from time to time in regard to the heat, and a number of holes made in the cover, to be opened or cloſed according to the exceſs or deficiency of heat . . . . . The copious moiſt, fetid vapours, to which the Eggs are here expoſed, prove often fatal to the embryo; and a good deal of care is requiſite to ſecure them from theſe vapours. This Mr. Reaumur very often

SECT. X.

Unctuous Parts of ANIMALS.

FAT.

FAT is an unctuous ſubſtance, ſecreted from the blood, and lodged chiefly in the *Membrana adipoſa*. Strong exerciſe, preternatural heat, an acrimonious ſtate of the juices, and other like cauſes by which the oily parts of the blood are attenuated, reſolved, or evacuated, prevent the generation of fat: Labours of the mind alſo have this effect, as well as labour or intemperature of the body. Hence reſt and plentiful food are ſufficient to fatten brutes, but in men it is often otherwiſe. It is ſurprizing how ſoon ſome birds grow fat; Ortolans in four and twenty hours, and Larks ſtill ſooner.

Fats may be divided, from their conſiſtence, into three kinds; (1.) The ſoft and thin, which grow perfectly liquid in a very ſmall heat; (2.) The thick or conſiſtent, which liquefy leſs readily; and (3.) The hard and firm, which require a ſtill ſtronger heat to melt them. The firſt is called *Pinguedo*; the ſecond *Axungia*; and the third *Adeps* as taken from the animal, and *Sebum* or *Sevum* when freed from the ſkins, *&c.* This uſe of the names is not however conſtant, ſome applying them differently.

In birds, reptiles, and fiſhes (the very large fiſhes excepted) we find only the firſt kind, or the thin fat, in quadrupeds chiefly the two laſt, in ſome moſt of the one, and in others of the other.

A great number of fats have been kept in the ſhops, for making ointments, plaſters, and other medicinal compoſitions; as Hog's Lard, the fat of the Boar, the Fox, the Hare, Dog, wild Cat, Alpine Mouſe, Beaver; of Hens, Ducks, Geeſe, Storks; of the Whale, Pike, Serpents, Vipers, *&c.* as alſo human fat.

Purification.

In regard to all theſe kinds of ſubſtances, much depends upon the manner of purifying or trying, and of keeping them, for they are very apt to ſpoil and grow rancid. Dioſcorides directs them to be barely melted in a gentle warmth: Some previouſly waſh them in hot and cold water, or in Wine, but either of theſe liquors do more harm than good. Simple fuſion in a water-bath or other gentle heat is ſufficient; the ſkins, fibres, and blood-veſſels, being previouſly ſeparated, and the melted fat further purified by paſſing through a ſtrainer. If any ablution is thought neceſſary, rectified Spirit of Wine is the moſt proper liquor; for this, if any of it ſhould be retained in the fat, will be diſſipated in the melting. For the more curious and uncommon fats, the beſt way is, to clear them from ſkins, *&c.* then waſh them with rectified ſpirit, and keep them

often experienced; and it is by this he ſeems to have been miſled. Having ſo often ſeen the ill effects of the redundant moiſt vapours of dung, he thought it a grand advantage, in ovens warmed by culinary fire, to have no moiſture at all.

them covered with fresh spirit, in a close vessel, in a cool cellar: A little may be soon melted, occasionally, in a glass, and strained off for use. FAT.

Fats taken freely as food, are difficult of digestion, relax and weaken the tone of the stomach and intestines, and are supposed likewise to render the juices tenacious, and to increase Bile. They are used in external applications for softening and suppling, for abating pains and spasms, and for promoting maturation: But it is proper to observe, that in inflammations, recent wounds, in defensive plasters, for varices, or where the bones are carious or laid bare, they do harm. The great number of fats which the shops have been accustomed to preserve, do not appear to be all needful: Dr. Cyprianus, who practised surgery in London, scarcely employed in his own practice any fats at all.

Formerly human fat was held in great estimation, and incredible virtues were ascribed to it. Some endeavoured to subtilize, and prepare a quintessence from it, by distillation from bricks, ashes, and other additions: Agricola, to make the ingredients more homogeneous, distils it from human bones. When thus subtilized, it is said to be of inexpressible activity and penetration, insomuch that when rubbed on the palm of the hand, it is felt, in the twinkling of an eye, at the back-bone: So great is the efficacy of a distempered imagination.

THOUGH fats differ from one another not a little in their obvious properties, and probably also in their medicinal and dietetic qualities; they afford, upon a chemical analysis, products similar in quality, and differing but inconsiderably in quantity. They all yield a large proportion of Oil, and no volatile Salt; in which last respect they differ from the other substances of the animal kingdom. Analysis of Fats.

TWO ounces of the fat of a Goose being distilled in a glass retort, at first in a sand-heat and afterwards in an open fire; there arose one dram of a slightly empyreumatic liquor, and one ounce six drams fifty grains of a clear brown coloured Oil of a volatile smell somewhat like that of Horse-radish. The Caput mortuum was of a shining black colour, and weighed ten grains. FAT of a GOOSE.

Two ounces of Hog's Lard gave two drams of empyreumatic liquor, and one ounce five drams fifty grains of Oil, of the same volatile smell with the foregoing; the Caput mortuum was also of the same black colour, and of the same weight; so that this fat differs from the foregoing, only in yielding a dram more of empyreumatic liquor or phlegm, and a dram less of Oil. HOG'S LARD.

I examined Lard with different menstrua, as well as by fire; namely, rectified Spirit of Wine, Water, the acid Spirits of Vitriol, Nitre, and Sea-salt, Spirit of Sal ammoniac, common alcaline Ley, and caustic Ley: None of these liquors dissolved, or had any effect upon it, in the cold or when assisted by a moderate heat, except that the Spirit of Sal ammoniac seemed, by its turbidness, to have taken up a little of the fat. By boiling, it unites perfectly, like other fats, with caustic Ley, and forms with it a saponaceous mass.

TALLOW, of common use for making Sope and Candles, being distilled as the two foregoing fats, I obtained from two ounces of the Tallow, of empyreumatic TALLOW.

TALLOW. empyreumatic liquor two drams; and of a clear brown Oil, which ſmelt like Horſe-radiſh, one ounce ſix drams twelve grains. The remaining coal was of a ſhining black colour, and weighed eighteen grains.

MUTTON SUET. TWO ounces of Mutton-ſuet yielded one dram and a half of empyreumatic liquor, and one ounce ſix drams fourteen grains of Oil: The ſhining black Caput mortuum weighed ſixteen grains.

Thus we ſee how little differences there are even in the proportion of the principles, into which different fats, hard and ſoft, are reſoluble by fire.

MARROW. THE MARROW of bones differs a little from the direct fats, in its chemical analyſis, as well as in its pleaſanter taſte.

Four ounces of the freſh Marrow of the leg-bone of an Ox, committed to a warm preſs, paſſed nearly all through the bag, in form of a fine liquid fat, which hardened in cooling like other fats; only one dram of fine fibres and membranes was left.

The ſtrained Marrow, digeſted in rectified Spirit of Wine, ſuffered no change, and communicated nothing to the ſpirit: By boiling four drams of the Marrow in diſtilled water, and evaporating the decoction, I obtained three grains of an extract, which had neither taſte nor ſmell: The three mineral acids, and Spirit of Sal ammoniac, had not the leaſt action on it: Strong alcaline Ley ſeemed to corrode it a little; and cauſtic Ley formed with it a conſiderably ſaponaceous compound. In theſe reſpects, it agrees ſufficiently with other fats: The principal difference is in the diſtillation.

Four ounces, diſtilled in the uſual manner, gave over three drams and a ſcruple of a liquor which ſmelt like Tallow, two ſcruples and a half of a liquor which had more of an empyreumatic and a ſouriſh ſmell, two ounces and a half of a yellowiſh-brown butyraceous Oil which ſmelt like Horſe-radiſh, and ſix ounces and a half of a blackiſh-brown Oil of the ſame ſmell: The Caput mortuum weighed four ſcruples.

BRAINS. THE BRAINS of land animals differ ſtill more from the direct fats, and agree nearly with the fleſhy parts. They yield in diſtillation an actual volatile Salt; and an empyreumatic Oil, ſimilar to that obtained from fleſh, bones, *&c.* without any thing of the peculiar Horſe-radiſh ſmell of the diſtilled Oils of fats.

From ſixteen ounces of Oxes brains, cleared as much as poſſible from the membranes, there aroſe ſix ounces two drams two ſcruples of a colourleſs phlegmatic liquor, which ſmelt nearly like hung beef; four ounces four ſcruples of a volatile urinous empyreumatic liquor or ſpirit; and four ounces and a half of empyreumatic Oil. The urinous ſpirit yielded on rectification two ſcruples of a concrete volatile Salt. The Caput mortuum, which weighed one ounce, on being burnt to whiteneſs and elixated with water, gave twenty-five grains of fixed Salt, though Hoffmann reports that no fixt Salt is procurable from animal brains.

SPERMACETI. THE brain of a ſpecies of Whale, purified from the oily matter, affords a fat of a ſingular kind, known in the ſhops by the improper name of SPERMACETI.

The

The Spermaceti Whale, called *Cetus dentatus* and *Orca*, and by the Engliſh failors employed in the Greenland-fiſhery *Trump*, *Jubart*, or *Gibbart*, is ſmaller than the common Whale, but the head is proportionably much larger, amounting to above one third the bulk of the whole body. He is furniſhed with teeth, which the other is not; and wants the flexible bones in the mouth, called Whale-bone, which the other has. The throat is alſo remarkably wider. SPERMACETI.

One of theſe fiſhes affords ſome tuns of brains; which are firſt groſsly freed from the Oil by draining and preſſing, and afterwards more perfectly purified by ſteeping them in a Ley of alcaline Salt and Quick-lime, which diſſolves the remains of the oily matter into a ſaponaceous liquid. The brains, being then waſhed with water, appear of a Silver whiteneſs; and nothing more is required to complete the preparation, than to cut them in ſhivers with wooden knives, and ſpread them abroad to dry. Such is the ſimple proceſs, by which this profitable commodity is prepared. It has been ſaid that Spermaceti is a natural concrete, found floating on the ſurface of the northern ſeas; but this is plainly a falſe report, perhaps calculated to prevent enquiry into the manner of its preparation.

Good Spermaceti is in fine white flakes, gloſſy and ſemitranſparent, ſoft and unctuous to the touch, yet dry and eaſily friable, in taſte ſomewhat like Butter, of a faint ſmell like that of Tallow.

It is apt in keeping, if not carefully ſecured from the air, to grow yellowiſh, and contract a rancid fiſhy ſmell. The more perfectly it has been purified at firſt, the leſs ſuſceptible it is of theſe alterations; and after it has been ſo changed, it may be rendered white and ſweet again, by ſteeping it afreſh in a Ley of alcaline Salt and Quick-lime.

It melts in a ſmall degree of heat, and congeals again as it cools. Laid on burning coals, it emits a fetid ſmell, like that of the ſnuff of a candle. The contact of flame does not ſet it on fire, but with a wick it burns equally with common Tallow-candles.

In diſtillation, it totally ariſes, leaving no coal or Caput mortuum behind: From four ounces were obtained three ounces and a half of Oil, and a dram and a half of phlegm; the other two drams and a half having been waſted or diſſipated in the proceſs. The Oil is not a brown or black fetid empyreumatic one, like thoſe of other animal ſubſtances; but clear, yellowiſh, of a butyraceous conſiſtence, in ſmell like Oil of Wax, like which alſo it coagulates in the cold.

Rectified Spirit of Wine, digeſted and boiled with Spermaceti, takes up about half a dram out of half an ounce: Greateſt part ſettles to the bottom, and the finer particles float in the liquor, in appearance like flowers of Benzoine.

Water, long digeſted or boiled with it, extracts nothing. By grinding it with Sugar or Almonds, it becomes miſcible with water, but not near ſo perfectly as the vegetable Reſins do by the ſame treatment; on ſtanding for a little time, the Spermaceti ſeparates and floats on the ſurface. Yolks of eggs unite it more thoroughly with watery liquors; but when diſſolved by theſe alſo it ſoon ſeparates, and falls to the bottom.

SPERMACETI. Even caustic alcaline Ley does not dissolve, nor unite with it into Sope, as it does with all other fats; and hence the use of this Ley in its preparation and purification. It mingles sufficiently with Oils, Fats, Balsams, Resins, Butter, Wax, *&c.*

TRAIN OIL. THE common Whale contains an immense quantity of soft fat, which liquefies in a gentle warmth: Hence the animal cannot live in seas that are but moderately warm, and is found only in the cold northern ones, about Greenland, Iceland, *&c.*

Common Train-oil is the fat of the Whale, melted out from the fleshy parts. The French extract it in Greenland from the fresh Blubber; whereas the English, Dutch, *&c.* bring home the fish itself, cut in pieces, which putrefying by the length of time, give a more offensive Oil.

Sixteen ounces of Train-oil yielded in distillation an ounce of phlegm, and twelve ounces and a half of empyreumatic Oil: The remaining coal weighed one ounce and a half.

CIVET. ODORIFEROUS unctuous juices are secreted in the inguinal region of certain animals, and deposited in particular bags. CIVET, used in perfumes, is collected betwixt the anus and the organs of generation of a fierce carnivorous quadruped, met with in China and the East and West-Indies, called a civet *Cat*, but bearing a greater resemblance to a Fox or a Martin than a Cat.

Several of these animals have been brought into Holland, and afford a considerable branch of commerce, particularly at Amsterdam. The Civet is squeezed out, in summer every other day, in winter twice a week; the quantity procured at once is from two scruples to a dram or more. The juice thus collected is much purer and finer than that which the animal sheds against shrubs or stones in its native climates.

Good Civet is of a clear yellowish or browniſh colour; not fluid, nor hard, but about the consistence of Butter or Honey, and uniform throughout; of a very strong smell, quite offensive when undiluted, but agreeable when only a small portion of Civet is mixed with a large one of other substances.

This commodity is rarely or never to be met with genuine, notwithstanding the sealed bottles in which it is purchased at Amsterdam. Nor have we any certain criteria for distinguishing its adulteration. Some look upon it as genuine, if when rubbed on paper, it sinks in, without leaving any thing upon the surface; and if, when melted in hot water, it totally swims a top: But Lard and Butter, the substances principally mixed with it, have both these properties, equally with the Civet itself.

Civet unites easily with Oils, both expressed and distilled, but not at all with Spirit of Wine, nor with water: Nor is it rendered miscible with water by the mediation of Sugar. Boecler relates, that Sugar and rectified Spirit are its two best menstrua; but he has certainly never made the experiment with either. The yolk of an Egg seems to dispose it to unite with water; but in a very little while, the Civet separates from the liquor and falls to the bottom, though it does not prove of such a resinous tenacity as when treated with Sugar and Spirit of Wine.

It

It communicates however ſome ſhare of its ſmell both to watery and ſpiritu- CIVET.
ous liquors: Hence a ſmall portion of it is often added in odoriferous tinctures, and ſuſpended in the ſtill-head during the diſtillation of odoriferous waters and ſpirits; as thoſe of Lilies of the valley, Roſes, Rhodium-wood, Orange-flowers, Orange-peel, Yellow-ſaunders, *&c.* The Italians make it an ingredient in perfumed Oils, and thus obtain the whole of its ſcent; for Oils diſſolve the whole ſubſtance of the Civet.

MUSK is a concrete juice, collected in a bag, which is ſituated under the belly of an oriental quadruped, called by ſome a Goat, by others a Stag, but differing conſiderably from the animals of both thoſe claſſes; for I have ſeen both the dried ſkin and the animal alive. Of all the figures I have met with in books, Pomet's comes the neareſt to it. The Muſk-bag has no external opening like that of the Civet Cat; and hence the Muſk is not to be got at till the beaſt is killed. I obſerved however, that the apartment in which he was kept, ſmelt exceeding ſtrongly of Muſk; and that on the whited walls, where he rubbed himſelf, there was an unctuous matter of the ſame ſcent. MUSK.

Two ſorts of Muſk are diſtinguiſhed in trade; one incloſed in the bags, and the other taken out of them; and each of theſe is ſubdivided, from the countries whence it is brought, into Tunquin or Eaſt-Indian, and Muſcovy or Perſian Muſk. The Tunquin bags have commonly ſmall browniſh hairs; the Perſian, larger white ones. The former are accounted the beſt; but the difference ſeems to be only in the quantity, and not in the quality, of the Muſk; the thinner and leſs hairy ones containing more, in proportion to their weight, than the others.

As Muſk is one of the deareſt of the drugs, it is for the moſt part grievouſly adulterated. Some think to avoid being impoſed on by buying the entire bags: But the more ingenious artiſts have contrived means of opening them, taking out great part of the Muſk, filling them with baſe materials, and cloſing them up again ſo as not to be diſtinguiſhed; ſometimes pieces of Lead are introduced, to increaſe the weight: Some bags are entirely counterfeit, the bag being made of the ſkin of other animals, and its contents only ſcented with Muſk.

Sundry criteria of the genuineneſs of Muſk are mentioned by authors, but as none of them are anywiſe to be depended on, they need not be enumerated here. The only way of judging whether it is genuine or good, is, to compare it with ſpecimens known to be ſo.

With regard to its appearance, it is either of a browniſh-black or a ruſty reddiſh colour, ſometimes clotty like coagulated blood, dry, with a kind of unctuoſity to the touch. Its taſte is ſomewhat bitteriſh; its ſmell extremely ſtrong, diſagreeable when ſmelt near to, or in large quantity, but to moſt people very agreeable at a diſtance, or when diluted with a very large admixture of other matters.

Of all the natural ſubſtances I know, Muſk has the ſtrongeſt ſmell; and great care is requiſite in keeping it, to prevent the diſſipation of this volatile principle, in which its virtue conſiſts. The uſual way is, to ſecure it in a cloſe ſtopt glaſs; to incloſe this in a leaden caniſter to tie a piece of bladder round the juncture; and place the whole in a cool dry cellar: Warmth

MUSK. would promote the exhalation, and moiſture would occaſion the Muſk to ſpoil and grow mouldy.

The ſmell of Muſk is remarkably diffuſive, and remarkably tenacious: Every thing in its neighbourhood becomes preſently infected with it; and what has once received, retains it long: A ſilver cup, that has had Muſk in it, does not eaſily part with the ſcent, though other ſmells are in general very readily diſcharged from metalline bodies. Some report that Muſk which has loſt its ſmell recovers it again on being hung in a privy; and that this is the common practice among the perfumers.

Thirty grains of Muſk, digeſted with water, gave twelve grains of extract: The ſame quantity, treated with rectified ſpirit, only ten grains. The Muſk remaining after the action of water gave out four grains to ſpirit; and that remaining after the action of ſpirit gave ſix grains to water.

Spirit of Nitre and Oil of Vitriol totally diſſolve it; the former deſtroys the whole of its ſmell, and the latter greateſt part of it. The diluted acid or Spirit of Vitriol has no effect; and Spirit of Salt, and diſtilled Vinegar ſcarcely any.

Spirit of Sal ammoniac diſſolves a little; the dulcified Spirit of Sal ammoniac, leſs. Oil of Tartar per deliquium ſcarcely acquires any tinge from the Muſk, but extricates in digeſtion a volatile urinous ſmell, as if Muſk contained an ammoniacal Salt, whoſe acid being abſorbed by the fixed alcaline Ley its volatile Alcali is ſet at liberty.

Oils ſeem to have no action on it; for Muſk being triturated with the expreſſed Oil of Almonds, with the diſtilled eſſential Oil of Lavender, and with the undiſtilled eſſential Oil of Citron-peel, it did not diſſolve, or unite with any of them.

Laid on a burning coal, it emits the ſame fetid ſmell as urine does. On diſtilling a little in a retort, I obtained the ſame products as from other animal ſubſtances, namely an empyreumatic Oil, and a volatile Spirit and Salt.

The principal uſe of Muſk is as a perfume, for clothes, ſcented Sopes, balſams, waters, ſpirits. Some direct it in odoriferous compoſitions for burning; but for theſe purpoſes it is manifeſtly improper, as the ſmell which it yields when ſet on fire is, like that of other animal ſubſtances, very fetid and offenſive.

A ſmall portion of it, included in a linen-cloth, is commonly hung in the ſtill-head, in the diſtillation of odoriferous waters and ſpirits; the vapours of both liquors extracting its ſcent. If put into the ſtill along with ſpirit, the ſpirit which diſtils has nothing, or exceedingly little, of its ſcent; but water diſtilled over from it in the ſame manner, is extremely ſtrong both in the ſmell and taſte of the Muſk (*m*).

This drug is ſometimes given by phyſicians as an antiſpaſmodic and corroborant; but there are many, particularly women, who cannot bear its ſmell.

IN

(*m*) *Muſk in perfumed waters.*] The waters and ſpirits, diſtilled from odoriferous vegetables, as Lavender and Roſemary-flowers, have their fragrance notably improved by ſkilfully impregnating them with a minute portion of Muſk; the Muſk, when employed in very ſmall quantity, heightening the ſmell of other odoriferous ingredients, without communicating to the compound any of its own diſtinguiſhing ſmell.

The

IN the inguinal region of the BEAVER are found four oval bags, a large and a ſmall one on each ſide. In the two large is contained a ſoftiſh, greyiſh-yellow or light brown ſubſtance; which, in a warm dry air, grows by degrees hard and brittle, and of a darker and browner colour, eſpecially when dried, as it uſually is, in chimneys: This is the CASTOR of the ſhops; when freſh, it has a very ſtrong, diſagreeable ſmell, which is greatly weakened by drying. The two ſmaller bags contain a ſofter and more unctuous fat, of the ſame kind of ſmell with the Caſtor, and which is uſed by huntſmen for rubbing on their toils, as a decoy for Foxes, Martins, and other beaſts of prey, who purſue the Beaver by his ſcent. CASTOR.

The Beaver is an amphibious quadruped; in the fore-part like land animals; the two hind feet ſomewhat like thoſe of water-fowls; the tail like that of fiſhes: Hence in ſome countries the hinder-part is permitted on faſt-days, and the fore-part forbidden. His habitation is curiouſly conſtructed in the banks of rivers or lakes, and divided into ſtories at different heights for retiring to when the water is high or low. He has two kinds of hair, a long coarſe, and a fine ſhort ſoft one underneath: The entire ſkin is made into muffs, and the ſhort hair into hats, *&c.*

There are Beavers in Pruſſia, Muſcovy, Poland, and other parts of Europe, but the greateſt numbers are in America, particularly Canada. All the European Beavers are of a brown or blackiſh-brown colour: Of the American, there are ſeveral fallow, ſtraw-coloured, and ſome quite white.

It is ſuppoſed, in Germany, that England produces Beavers; a ſort of Caſtor being diſtinguiſhed in trade by the name of Engliſh Caſtor. This is not, however, originally an Engliſh but an American drug, being brought from America into England, and from thence to us. The Engliſh themſelves rarely make uſe of it, preferring that of Pruſſia, which they receive from Dantzick. The Pruſſian is undoubtedly the beſt; and next to it is that of Muſcovy.

The Caſtor of the full-grown Beaver is ſuperior to that of the young; and hence the large cods are to be preferred to the ſmall. The beſt are moderately heavy, of a blackiſh-brown colour, of a ſtrong penetrating ſmell, well filled with a browniſh, hard, brittle ſubſtance, of a nauſeous bitteriſh taſte, intermixed with fine ſkins or membranes.

We ſeldom meet with any conſiderable quantity of this commodity free from adulteration. Some open the cods, and having emptied them of their contents, fill them with other matters, and glue up the ſlit with Iſinglaſs ſo dextrouſly that no mark of it can be perceived. The more ſubtile maſters of deceit employ for filling the cods a compoſition greatly reſembling the Caſtor itſelf, made of blood, dried and powdered, Gum ammoniacum, Galbanum, Mummy, Reſin, Wax, *&c.* with a little powdered Caſtor, and the inguinal fat of the animal.

The beſt method of managing it for theſe perfumed liquors ſeems to be, to make a tincture from the Muſk in rectified Spirit of Wine; and drop this tincture into the liquor in ſuch quantity as ſhall be found neceſſary. This appears likewiſe to be the moſt certain way of judging of the goodneſs of Muſk; for the ſpirit extracts all its ſmell, and the quantity of liquor that may thus be ſenſibly impregnated by a certain quantity of Muſk, will be the meaſure of the ſtrength of the Musk.

CASTOR. mal. Some make a ſmall hole in the lighter cods, and introducing fine ſhot or other ponderous materials, artfully glue it up again.

An ounce of Caſtor digeſted with rectified Spirit of Wine, yielded two drams and a ſcruple of a tenacious extract: Another ounce, treated with water, gave exactly the ſame quantity of a brittle extract. The Caſtor, remaining after the action of each of theſe menſtrua, being treated with the oppoſite one, the quantities now taken up were different; ſpirit, applied after water, extracting only a ſcruple, and water after ſpirit four ſcruples.

The two laſt extracts have hardly any ſmell or taſte. The extract made by water at firſt retains the ungrateful bitterneſs of the Caſtor, but has little or nothing of its ſmell, the odoriferous principle ariſing with the water in evaporation or diſtillation: The diſtilled water ſmells exceeding ſtrongly of the Caſtor, and probably if a large quantity of the drug was ſubmitted to the operation at once, an actual eſſential Oil would be obtained (*n*), though on diſtilling a ſmall quantity I could not ſeparate any Oil. Rectified ſpirit brings over nothing in diſtillation, the ſmell as well as the taſte of the Caſtor remaining entire in the extract. Hence we learn how unfit this drug is for an ingredient in diſtilled ſpirits, and in watery extracts; in both which it is ſtill directed in [foreign] diſpenſatories.

Caſtor has been greatly celebrated by phyſicians as an antiſpaſmodic and antihyſteric medicine; the ancients accounted it likewiſe a corrector of Opium; perhaps rather from prejudice, than from fair experience of its virtue. When given by itſelf, it is not found to produce any of thoſe mighty effects, which have been uſually attributed to it.

SECT. XI.

ANIMAL GALL.

GALL. GALL or Bile is a bitter fluid, ſecreted from the blood in the liver, and collected in a particular receptacle; from whence it is gradually emptied into the alimentary canal, for promoting the reſolution of the aliment and the production of chyle, and for ſtimulating the inteſtines to diſcharge the feces. The Galls of different animals do not ſeem to differ conſiderably from one another: The following experiments were made on that of the Ox.

Gall-ſtones. THE gall-bladder of an Ox contains commonly from eight to twelve ounces of Gall. There are frequently found in it one or more calculi, ſome as

(*n*) *Probably would yield an eſſential Oil.*] This ſuſpicion has been confirmed by experiment, an actual Oil having been obtained on diſtilling large quantities of Caſtor at once. Dr. Cartheuſer obſerves that this Oil "is ſo ſubtile, that a ſingle drop re- "ſolved into vapour, is capable of filling a "large extent of air with the ſpecific ſmell "of the Caſtor." *Fund. Mat. Med. Sect.* xii. *cap.* 48.

as large as a Pigeon's or ſmall Hen's egg, of a yellow colour like Gamboge, and compoſed of ſtrata or incruſtations like Bezoar; whence they have been called Bezoar of the Ox. Theſe ſtones are partly diſſoluble, by the aſſiſtance of a boiling heat, both in water, and in rectified Spirit of Wine. GALL.

The freſh Gall is in part yelloviſh, in part of a browniſh-greeniſh colour, of conſiſtence ſomewhat thinner than the whites of eggs, of a very bitter taſte, and little ſmell. On keeping it grows thicker and more tenacious, at length appears turbid and cloudy, depoſites a ſediment, and putrefies. In Nature of Gall.

Gall is ſuppoſed by ſome to be an acid, by others an alcaline, and by others a ſopy liquor; but it does not appear to be any one of theſe. Nothing alcaline can be diſcovered in it, till it has undergone the action of fire or of putrefaction, by which an alcali is generated in this as in other animal ſubſtances: And no acid can be diſcovered in it in any ſtate. As it contains no alcaline Salt, it cannot be ſopy; for Sope is a combination of alcaline Salt and Oil. Gall is a fluid of a peculiar kind, for we know of no other ſubſtance in nature that can be ranked in the ſame claſs with it.

Spirit of Vitriol, Oil of Vitriol, Spirit of Nitre, Spirit of Sea-ſalt, and diſtilled Vinegar being dropt into ſeparate quantities of freſh Gall, each drop coagulated the part where it fell, and rendered it thick, tenacious and whitiſh (*o*). None of theſe acids occaſioned any effervescence, except the nitrous ſpirit; which in a little time after it was added, raiſed a ſlight kind of commotion, with an emiſſion of ſome vapours. Examined by acids, &c.

It is chiefly from this appearance of effervescence, with the nitrous acid, falſely extended to the other acids, that Gall has been ſuppoſed to be alcaline; but admitting the conflict to be far greater than it is, the conſequence would by no means be juſt: Spirit of Nitre produces a violent ebullition with eſſential Oils, which are ſo far from being alcaline, that if they contain any ſaline matter it is an acid.

The coagula which Gall forms with the above acids, diſſolve on ſtanding, and at length depoſite a little Precipitate, excepting the mixture with the nitrous acid, which after the reaction is over becomes clear again.

Oil of Tartar per deliquium added to Gall, throws down likewiſe a ſmall quantity of coagulated matter. Spirit of Sal ammoniac dilutes or uniformly mingles with it, without occaſioning the leaſt alteration. Rectified Spirit of Wine alſo ſcarcely makes it cloudy.

Gall diſtilled in the gentle heat of a water-bath, gives over a large quantity of an aqueous fluid. Some report, that when the Gall is previouſly digeſted, the diſtilled liquor ſmells like Muſk; and others, that the firſt runnings are inflammable: But I have never obſerved any degree either of a muſky ſcent, or of By diſtillation.

(*o*) *Bile with acids*, &c.] Though Bile is oftentimes made whitiſh by acids, Baglivi relates, that human Bile, and that of an Ox and a Sheep, were changed by acids to a green colour: Hence it is ſuppoſed that a green colour of the inteſtinal feces proceeds from acid juices mingled with the Bile. Salt of Tartar, dropt into Bile, remained in great part undiſſolved at the bottom, this fluid ſeeming to have very little action upon the Salt: The Bile nevertheleſs had its bitterneſs increaſed by the Alcali to ſuch a degree as to occaſion vomiting on being ſlightly taſted. Acids on the other hand weakened the bitterneſs, and volatile ſpirits rendered it not ungrateful. See Baglivi *Diſſertationes variæ*, *Diſſ.* iii. *de Bilis natura*.

GALL. of inflammability: When Gall is digeſted in a gentle warmth, it begins to putrefy, and the liquor that diſtils from it is no other than an urinous one, having the common fetid urinous ſmell, and changing Syrup of Violets green; for though recent animal ſubſtances require a ſtrong fire for generating and extricating an urinous Alcali from them, yet when the Alcali is once produced by putrefaction, it ariſes in a gentle heat.

Freſh Gall inſpiſſated and freed from its phlegm in a water-bath, yields on being diſtilled in an open fire, an urinous ſpirit, a volatile alcaline Salt, and an empyreumatic Oil; and from the Caput mortuum may be obtained a conſiderable proportion of a true fixed alcaline Salt. Eight ounces of Gall yielded ſix ounces and a half of phlegm or water, including the phlegm of the ſpirit; half a dram of volatile Salt, including the Salt in the ſpirit, and nearly four ſcruples of empyreumatic Oil. The Caput mortuum, which weighed two drams and a half, on being urged with a ſtronger fire, gave over a little thick oily matter, and a ſmall portion of yellow Sublimate: From the reſiduum were extracted, by calcination and elixation, twenty-one grains of fixed Alcali; the remaining white earth weighed, when dry, one dram and ſix grains.

I afterwards repeated the experiment with a larger quantity of Gall: From the Galls of ſeven Oxen I obtained no leſs than half an ounce and a ſcruple of pure fixed alcaline Salt; a product the more remarkable, as animal ſubſtances in general afford exceeding little fixt Alcali, and moſt of them ſcarcely any at all.

Its uſes. Ox's Gall has been made an ingredient in external applications for cutaneous deformities, and ſometimes alſo directed by phyſicians to be given internally. In the ſhops it has been cuſtomary to inſpiſſate the Gall in a water-bath, and then extract a tincture from it with Spirit of Wine; after the inſpiſſation it almoſt totally diſſolves again both in ſpirit and in water.

In France, it is made the baſis of a coſmetic mixture: The ingredients added to it are, Alum, Sandiver, Porcelane reduced into a ſubtile powder, diſtilled Vinegar, Borax, Spermaceti, Sugar-candy, Camphor, Mercurius dulcis; a ſtrange medley of diſcordant matters: One of the French academicians, in the Memoirs of the Academy for the year 1709, gives the following preparation of Gall for taking out freckles and ſunburn: Sixteen ounces of Ox's Gall are to be well beat up with half an ounce of powdered Alum, and the mixture ſuffered to ſtand in the ſun for two or three months; a ſediment falls to the bottom, amounting to more than the weight of the Alum employed; and an unctuous fat matter ariſes to the ſurface; from both which the clear reddiſh liquor in the middle is to be ſeparated: The coſmetic conſiſts of one dram of this liquor, the ſame quantity of Oil of Tartar per deliquium, and eight drams of river water, with which mixture the part is to be touched ſeven or eight times a day.

Unctuous and reſinous bodies, triturated with Gall, become ſoluble in water: Hence Gall is employed in preparing certain ſubſtances of that claſs for painting in water colours; for ſcouring, taking out ſpots, &c.

SECT. XII.

MILK.

THE nutritious parts, extracted from vegetable aliments by the powers of digeſtion, appear firſt in the form of a whitiſh liquid called Chyle, which is but little removed from a vegetable nature. On drawing blood from a vein of a healthy animal, four or five hours after feeding, a portion of chyle is often found floating on its ſurface. Soon after this period, the chyle is animalized, and in its place only a thin ſerum is to be ſeen. MILK.

Its nature and differences.

Milk is the chylous part of the blood, ſecreted by organs adapted to that uſe, and ſomewhat more aſſimilated to an animal nature, but not as yet completely ſo; the ſpecific qualities of ſundry vegetable ſubſtances, both alimentary and medicinal, remaining unſubdued in the Milk.

Thus Milk, and the Butter made from it, are found to differ greatly, in colour, conſiſtence, taſte and ſmell, according to the food of the animal (*p*). The human Milk is made yellow by taking Saffron, bitter by Wormwood, and impregnated with a Garlic ſmell by eating that root: A purgative given to a nurſe purges the child at the breaſt; and the inebriative power of fermented liquors is in like manner communicated by the Milk. The ſweet ſaccharine ſubſtance parable from Milk by inſpiſſation and cryſtallization, and the inflammable ſpirit by fermentation and diſtillation, proceed ſolely from its vegetable part.

That it participates alſo of an animal nature, appears from its butyraceous fat matter, and from its analyſis by fire. If retained long in the breaſt or udder, without being recruited by freſh aliment, it changes more and more to an animal ſtate, and becomes a thin, ſaline, putrid, urinous ſerum. The more animal matter is uſed in the food, the more does the Milk participate of the qualities of animal ſubſtances, and the more it is diſpoſed to putrefaction.

The

(*p*) *Milk altered by the food.*] The Milk of Cows, and the Butter made from it, are obſerved to receive an ill flavour from many kinds of vegetables; from all the plants of the Garlic kind, from many of the umbelliferous plants, from the Horſe-mints, Cabbages, Turneps, autumnal leaves, *&c.* This ill taſte may in ſome meaſure be diſſipated from the Milk by a ſcalding heat.

Dr. Hales has diſcovered an uſeful and ſimple method of promoting the diſſipation of the more volatile parts of fluids, in a very high degree, by blowing ſtreams of air through the liquor. Stinking water, by ventilation for a little time, becomes perfectly ſweet and potable; the air carrying off the offenſive corrupted matter. By the ſame means Milk is effectually freed from its ill ſmell, eſpecially if made of a ſcalding heat whilſt the air is blown through it: It may be ſweetened by ventilation in the cold, but not ſo readily nor ſo perfectly as when heat is called in acid. See his *Account of a uſeful diſcovery to diſtil double the uſual quantity of ſea-water, by blowing ſhowers of air up through the diſtilling liquor.*

MILK. The Milks of different animals differ, in their perfect ſtate, notably from one another. It is remarkable of that of the Aſs, that it contains more than any other that has been examined, of a ſerous fluid, and leſs of a butyraceous and caſeous matter; and that when coagulated, the curd is not denſe and heavy, like that of other Milks, but rare and light.

Analyſis of the Milk of different animals.

Hoffmann evaporated eight ounces of Aſſes Milk by a gentle heat, and had only ſix drams remaining, of a whitiſh ſweet ſubſtance. He ſet by twelve ounces in a cloſe veſſel, to curdle; and having ſeparated and dried the curd, found it to amount ſcarcely to two drams, whilſt that produced from the ſame quantity of Cows Milk weighed ten drams.

Twelve ounces of Cows Milk ſet to evaporate in a tin veſſel, left one ounce five drams of a yellow clotty powder: The ſame quantity of Goats Milk left one ounce four drams and a half; of human Milk, one ounce; and of Aſſes Milk, ſcarcely an ounce.

The powder left in the evaporation by Cows Milk being boiled with twelve ounces of rain water, and the liquor paſſed through a ſtrainer, there remained one ounce three drams and a half undiſſolved, the water appearing to have diſſolved one dram and a half; on inſpiſſating the liquor, however, only a dram of ſolid matter was obtained. The powder of Goats Milk gave out to water the ſame proportion; but that of Aſſes Milk a much larger one: An ounce of this being digeſted with two pounds of water, there remained upon the ſtrainer only a dram and a half, ſo that the water had diſſolved ſix drams and a half, and accordingly upon evaporating the liquor, the reſiduum amounted to above ſix drams. The ſubſtance thus extracted by water from inſpiſſated Aſſes Milk was white, and of a ſaccharine ſweetneſs; and that obtained from human Milk was nearly ſimilar to it: That of Cows and Goats Milk was not only in leſs quantity, but far leſs ſweet.

I have obtained from Cows Milk a larger proportion of ſolid matter than Hoffmann did; a pint, evaporated to dryneſs, left two ounces and two drams. The Milk of one and the ſame animal is, at different times, very ſenſibly different in conſiſtence, and conſequently in its quantity of ſolid contents. But it muſt be obſerved, that though the quantity of ſolid matter is very variable, that of the ſaline ſubſtance which water extracts from it is much leſs ſo; the proportion of this ſubſtance in Cows Milk never being near ſo large, any more than its taſte ſo ſweet, as in Aſſes and Breaſt-milk.

Homberg diſtilled twelve ounces of Breaſt-milk in a glaſs body, and having drawn over the phlegm by a gentle fire, found ten drams remaining. This reſiduum, urged with a ſtronger heat, gave over two drams and half a ſcruple of fetid Oil, and ſomewhat more than half an ounce of an acid oily liquor: There was no appearance of any volatile Salt, either in a concrete or liquid form; but the Caput mortuum, calcined and elixated, gave a ſcruple of fixed Alcali, with a dram and a half of a white earth.

He repeated the experiment with Cows Milk, and found that this contained leſs phlegm, and of conſequence more ſolid matter. He obſerves that Goats Milk agrees very nearly with that of the Cow; and that Aſſes Milk has this remarkable particularity, of yielding a much more fetid ſmell in the fire than any of the others.

I di-

I diſtilled twelve quarts of Milk, in *balneo-mariæ*, and obtained at leaſt nine quarts of phlegm; the liquor which now aroſe was acidulous, and by degrees grew ſenſibly more and more acid as the diſtillation was continued. After this came over a little ſpirit, and at laſt an empyreumatic Oil. The remaining ſolid matter adhered to the bottom of the retort in form of elegant ſhining black flowers, and ſeemed in part to have penetrated and united with the Glaſs, and changed it into a ſubſtance reſembling Porcelane (*q*). This reſiduum, calcined and elixated, yielded a portion of alcaline Salt. MILK.

In du Hamel's *Hiſtoria academiæ ſcientiarum*, it is ſaid that the fixed Salt obtained from the Caput mortuum of Milk is not alcaline: I am pretty certain that mine was, for it turned Syrup of Violets green, and threw down a reddiſh Precipitate from ſolution of Mercury-ſublimate.

MILK, ſet in a warm place, throws up to the ſurface an unctuous creme; from which, by agitation, the directly unctuous part ſeparates in the form of Butter. BUTTER.

The addition of alcaline Salts prevents this ſeparation, not as ſome have ſuppoſed, by abſorbing an acid from the Milk, but by virtue of their property of intimately uniting oily bodies with watery liquors. Sugar, another grand intermedium betwixt Oils and water, has this effect in a greater degree, though that concrete is by no means alcaline, or an abſorbent of acids.

Butter is not acted upon in the leaſt by water, though ſtrongly digeſted or boiled with it. Rectified Spirit of Wine extracts a ſmall portion, which gives no taſte or colour to the ſpirit, but diſcovers itſelf by rendering the liquor white on the admixture of water. Analyſis of Butter.

From ſixteen ounces of freſh Butter, diſtilled in a retort, at firſt in ſand and afterwards in an open fire, there aroſe one ounce of liquor of no remarkable ſmell or taſte; one ounce and half a dram of a reddiſh acidulous liquor, which ſmelt like burnt Butter; five drams of a browniſh-yellow Oil, three ounces three drams of a yellow Oil, one ounce ſix drams of a white, and five ounces and a half of a yellowiſh-brown one, all of a thick butyraceous conſiſtence, and a volatile ſmell like that of Horſe-radiſh; and one ounce ſix drams of a thin empyreumatic Oil, which ſmelt like the *Oleum philoſophorum*, that is Oil Olive diſtilled over from bricks. There was not the leaſt mark of any volatile Alcali in the whole proceſs. The Caput mortuum weighed three drams and a half.

CHEESE is the curd of Milk, preſſed from the whey, and dried: It differs in quality according as it is made from new or from ſkimmed Milk, from the curd which forms ſpontaneouſly upon ſtanding, or that which is more ſpeedily produced CHEESE.

(*q*) *Glaſs changed into a ſubſtance like Porcelane.*] Our author appears to be the firſt who obſerved this extraordinary change of Glaſs. It was not owing however, as he ſeems to imagine, to any particularity of the earthy matter of the Milk; the ſame effect being produced by all the earthy bodies I have tried, as Sand, powdered Flint, Plaſter-of-Paris, Clay, burnt Clay, &c. and by inflammable bodies, as Soot and Charcoal. Of this remarkable change an account has been already given in page 479.

CHEESE. produced by certain additions, as the runnet of a Calf. Salt and ſpices are often added, and ſometimes the Cheeſe is tinged green, red or yellow, by vegetable juices. Creme alſo affords a kind of Cheeſe, but quite fat and butyraceous, and which does not long keep.

Analyſis of Cheeſe by menſtrua, An ounce of Cheeſe, digeſted with water, yielded a dram and a half of extract, which taſted of the Cheeſe, and had likewiſe a conſiderably ſaline taſte. Rectified Spirit of Wine extracted very little: During the digeſtion with the ſpirit, the unctuous matter of the Cheeſe ſeparated, and aroſe to the ſurface in form of an Oil.

Spirit of Nitre, digeſted with Dutch Cheeſe, totally diſſolved it into a limpid liquor, excepting that a little butyraceous matter floated on the ſurface, which liquefied on applying heat, and congealed again as it cooled. Spirit of Vitriol diſſolved it only in part; the ſolution was quite dark-coloured, and threw off an unctuous matter to the top, and fine capillary cryſtallizations to the bottom. Spirit of Sea-ſalt likewiſe proved only a partial menſtruum; the ſolution was yellow, and like the two foregoing had an unctuous ſubſtance on the ſurface.

Spirit of Sal ammoniac corroded the Cheeſe totally; and Oil of Tartar per deliquium corroded it partially; both liquors were turbid, and had an Oil at top. Cauſtic alcaline Ley diſſolved the whole; the ſolution was clear whilſt hot, but grew turbid on cooling; a little powdery matter ſeparated to the bottom, and a very little Oil to the ſurface——It is obſervable that the Cheeſe ſunk in Spirit of Salt and in Spirit of Sal ammoniac, but floated upon Spirit of Vitriol, Spirit of Nitre, Oil of Tartar, and cauſtic Ley.

and by fire. On diſtilling in a retort ſixteen ounces of Dutch Cheeſe, there aroſe ſeven ounces one dram and ten grains of urinous phlegm, two ounces thirty grains of volatile urinous ſpirit, ſix drams and a half of volatile urinous Salt, and three ounces three drams and a half of empyreumatic Oil: The Caput mortuum weighed two ounces fifty grains.

How different is this analyſis from that of Milk or Butter! Inſtead of a ſmall portion of acid which thoſe ſubſtances yield, we have here a large one of volatile Alcali; a mark that the Cheeſe has ſuffered a degree of putrefaction, or of a proceſs analogous to that by which vegetable ſubſtances are converted into an animal nature.

MILK. THE SWEET SACCHARINE part of the Milk remains diſſolved in the Whey after the ſeparation of the curd or cheeſy matter, and may be collected from it in a white cryſtalline form, by boiling the Whey till all remains of the curdled ſubſtance have fallen to the bottom, then filtering, evaporating it to a due conſiſtence, ſetting it to ſhoot, and purifying the cryſtals by ſolution in water and a ſecond cryſtallization. Much has been ſaid of the medicinal virtues of this SUGAR OF MILK, but it does not ſeem to have any conſiderable ones: It is from Cows-milk that it has been generally prepared; and the cryſtals obtained from this kind of Milk have but little ſweetneſs.

Sugar of Milk.

Whey. When Milk is ſuffered to coagulate ſpontaneouſly, the Whey proves acid, and on ſtanding grows more and more ſo till the putrefactive ſtate commences.

Sour whey is uſed as an acid, preferably to the directly vegetable or the mineral acids, in ſome of the chemical arts; as for diſſolving Iron in order to the ſtaining of Linen and Leather (*r*). MILK.

It is obſervable that Aſſes-milk is greatly diſpoſed, on ſtanding for a little time, to become thick and ropy. In the Breſlau collections for the year 1720, there is a remarkable account of Milk (which probably was that of the Aſs) grown ſo thick and tenacious as to be drawn out into long ſtrings, which when dried were quite brittle (*s*). Thick Milk.

The

(*r*) *Sour-milk.*] This acid is commonly made uſe of in the bleaching of linen, for diſſolving and extracting the earthy particles left in the cloth by the alcaline Salts and Lime employed for cleanſing and whitening it. Butter-milk is preferred to plain Sour-milk or Sour-whey: This laſt is ſuppoſed to give the cloth a yellow colour ... Dr. Home, in his ingenious treatiſe on this ſubject, recommends water acidulated with Spirit of Vitriol (in the proportion of about half an ounce, or at moſt three quarters of an ounce, to a gallon) as preferable in many reſpects to the acid of Milk, or of the more directly vegetable ſubſtances. He obſerves that the latter are often difficultly procurable, abound with oleaginous particles, and haſten to corruption; whilſt the vitriolic acid is cheap, and pure, and indiſpoſed to putrefy: That Milk takes five days to perform its office, whilſt the vitriolic acid does it in as many hours, perhaps in as many minutes: That this acid contributes alſo to whiten the cloth, and does not make it weaker though the cloth be kept in it for months. He finds that acids as well as alcalies extract an oily matter from the cloth, and loſe their acidity and alcalicity.

(*s*) *Milk---thick, tenacious.*] New Cows-milk, ſuffered to ſtand for ſome days on the leaves of Butterwort (*Pinguicula*) or Sundew, becomes uniformly thick, ſlippery, and coherent, and of an agreeable ſweet taſte, without any ſeparation of its parts. Freſh Milk, added to this, is thickened in the ſame manner, and this ſucceſſively. In ſome parts of Sweden, as we are informed in the Swediſh Memoirs, Milk is thus prepared for food.

New Milk has a degree of glutinous quality, ſo as to be uſed for joining broken ſtone-ware. There is a far greater tenacity in cheeſe properly prepared.

Sweet cheeſe, ſhaved thin, and ſtirred with boiling hot water, changes into a tenacious ſlime, which does not mingle with the liquor. Worked with freſh parcels of hot water, and then mixed, upon a hot ſtone, with a proper quantity of unſlaked Lime, into the conſiſtence of a paſte, it proves a ſtrong and durable cement for wood, ſtone, earthen-ware and glaſs. When thoroughly dry, which it will be in two or three days, it is not in the leaſt acted upon by water. Cheeſe barely beat with Quick-lime, as directed by ſome of the chemiſts for luting cracked glaſſes, is not near ſo tenacious.

Cheeſe, prepared as above, is recommended in the Swediſh Memoirs to be uſed by anglers as a bait. It may be made into any form, is not ſoftened by the water, and is liked by the fiſhes.

Further experiments on Milk.] Examined by a microſcope, it appears compoſed of numerous globules ſwimming in a tranſparent fluid.

It boils in nearly the ſame degree of heat with common water; ſome ſorts rather ſooner, and ſome a little later: After boiling, it is leſs diſpoſed to grow ſour than in its natural ſtate.

It is coagulated by acids both mineral and vegetable, and by alcalies both fixed and volatile: The coagulum made by acids falls to the bottom of the ſerum, that made by alcalies ſwims on the ſurface, commonly forming, eſpecially with volatile alcalies, a thick coriaceous ſkin: The ſerum, with alcalies, proves green or ſanious; with acids, it differs little in appearance from the Whey that ſeparates ſpontaneouſly. The

coagulum

MILK. Uſes of Milk.

The dietetic uſes of Milk and its products are well known. Milk itſelf is one of the moſt nutritious and ſalubrious aliments. Cheeſe is a ſtrong food, hard of digeſtion. Butter ſoftens and relaxes, obtunds acrimony, and if taken liberally blunts the activity of the gaſtric liquor, and weakens the digeſtive powers; Binetus calls it "Gold in the morning, Silver at noon, and Lead at "night." Where poiſonous ſubſtances, as Arſenic, have been ſwallowed, Milk and Butter, taken immediately and in large quantity are the beſt remedies for obtunding their force.

SECT. XIII.

ANIMAL EXCREMENTS.

URINE. Its remarkable products.

THE ſaline Lixivium, ſecreted from the blood in the kidneys and thence conveyed into the bladder, is a liquor of a very ſingular kind. That human Urine ſhould participate of the common alimentary Salt, is not extraordinary; but the Urine of brutes, who feed on mere vegetables, contains the ſame marine Salt: Whence does it proceed, or from what principle is it produced!

Urine contains alſo a peculiar ſaline ſubſtance, nowhere diſcovered but in Urine itſelf, ſeparable in a cryſtalline form, eaſily fuſible on a burning coal, and running into a round drop like melted Glaſs (*t*). Diſtilled by a ſtrong fire, it yields not only the volatile Salt and Spirit, and empyreumatic Oil, common in the animal kingdom, but a peculiar luminous and highly inflammable concrete called Phoſphorus of Urine.

There

coagulum formed by acids is diſſolved by alcalies, and that formed by alcalies is rediſſolved by acids; but the Milk does not in either caſe reſume its original properties.

It is coagulated by moſt of the middle Salts, whoſe baſis is an earth or a metallic body, as ſolution of Alum, fixed Sal ammoniac, Sugar of Lead, green and blue Vitriol; but not by the Chalybeate or purging mineral waters, nor by the bitter Salt extracted from the purging waters.

Among the neutral Salts that have been tried, there is not one that produces any coagulation. They all dilute the Milk, and make it leſs diſpoſed to coagulate with acids or alcalies: Nitre ſeems to have this effect in a greater degree than the other neutral Salts.

It is inſtantly coagulated by highly rectified Spirit of Wine, but ſcarcely by a phlegmatic ſpirit.

It does not mingle with expreſſed Oils.

All the coagula are diſſolved by Gall.

(*t*) *Peculiar Salt from Urine.*] This Salt, called by the chemiſts the *native*, *eſſential*, or fuſible Salt of Urine, or the *Microcoſmic Salt*, is moſt commodiouſly prepared, by putrefying a large quantity of Urine, and then ſlowly evaporating it to the conſiſtence of a thin Syrup; which being ſet in a cold place will yield, in three or four weeks, foul brown-coloured cryſtals, containing the microcoſmic Salt mixed with the marine or other Salts of the Urine. Theſe cryſtals are to be diſſolved in hot water, the ſolution filtered

filtered whilſt it continues hot, and ſet to cryſtallize again; and the ſolution, filtration and cryſtallization repeated, till the Salt becomes pure and white: In all the cryſtallizations, the microcoſmic Salt ſhoots firſt, and is eaſily diſtinguiſhed and ſeparated from the others. If the Urine which remains after the firſt cryſtallization, be further evaporated and ſet in the cold, it will yield more cryſtals, but browner and more impure than the former, and which are therefore to be purified by themſelves. From twenty gallons of Urine may be obtained about four ounces of pure Salt; a conſiderable part is ſtill left in the thick reſiduum. URINE.

In all theſe operations, the heat ſhould be moderate, and the veſſels either of glaſs or compact ſtone-ware. The microcoſmic Salt is a neutral ammoniacal one, compoſed of a peculiar acid united with a volatile Alcali: All other ammoniacal Salts ſublime entire on applying heat; but this ſingular Salt parts only with its Alcali, the acid remaining fixed, and incapable of concreting, by itſelf, into a cryſtalline form. Having once evaporated the putrefied Urine by a boiling heat in a copper veſſel, I obtained only a green ſolution of the Copper in the microcoſmic acid; from which I could never afterwards recover the ammoniacal Salt ſought for.

The pure microcoſmic Salt impreſſes on the tongue a ſenſe of coolneſs. It neither deliquiates in a moiſt air, nor becomes powdery in a dry and warm one. Laid upon a burning coal, it does not decrepitate like common Salt, but bubbles and melts like Borax, and runs into a colourleſs pellucid ſubſtance reſembling fine Glaſs: This apparent glaſs diſſolves eaſily in water, and proves on all trials notably acid; ſaturated with volatile Alcali, it cryſtallizes into microcoſmic Salt again. On mixing either the neutral Salt or the vitreous acid with inflammable ſubſtances, and diſtilling the mixture with a ſtrong fire, a phoſphorus ariſes, ſimilar to that obtained directly from inſpiſſated Urine.

We are obliged to the induſtry of Mr. Marggraf for a more particular examination of this very extraordinary Salt. The ſubſtance of his experiments, communicated in the Berlin Memoirs for the year 1746, is as follows.

Sixteen ounces of the Salt, diſtilled in a glaſs retort, in a ſand-heat gradually raiſed, gave over eight ounces of a volatile urinous ſpirit, reſembling that made from Sal ammoniac by Quick-lime. The reſiduum was a porous brittle maſs, weighing eight ounces: This, urged with a ſtronger fire in a crucible, bubbled and frothed much, and at length ſunk down into the appearance of Glaſs, without ſeeming to ſuffer any further diminution of its weight in the moſt vehement heat.

The vitreous matter diſſolved in twice or thrice its quantity of water, into a clear tranſparent acid liquor, ſomewhat thick, not ill reſembling in conſiſtence concentrated Oil of Vitriol. This liquor totally corroded Zinc into a white powder, which being diluted with water appeared in great part to diſſolve, fixed alcalies occaſioning a plentiful precipitation. It acted powerfully upon Iron, with ſome efferveſcence, and changed the metal into a kind of muddy ſubſtance, inclining to bluiſh, in part ſoluble in water like the preceding. It diſſolved likewiſe a portion of Regulus of Antimony, and extracted a red tincture from Cobalt. On Lead and Tin it had very little action: Copper it corroded but ſlightly: On Biſmuth, Silver, and Gold, it had no effect at all, either by ſtrong digeſtion or a boiling heat. Nor did the addition of a conſiderable portion of nitrous acid enable it to act upon Gold.

The vitreous Salt in its dry form, melted with metallic bodies by a ſtrong fire, acts upon them more powerfully. In each of the following experiments, two drams of the Salt were taken to two ſcruples of the metal reduced into ſmall parts. (1.) Gold communicated a purple colour to the vitreous Salt; on weighing the metal, however, its diminution was not conſiderable. (2.) Silver loſt four grains, or one tenth, and rendered the Salt yellowiſh, and moderately opake. (3.) Copper loſt only two grains, or one twentieth, though the Salt was tinged of a deep green colour. It ſeemed as if a portion of the Salt had been retained by the metal, which after the fuſion was found to be whiter and more brittle than before. (4.) During the fuſion with Iron, flaſhes like lightning were continually thrown out, a phoſphorus being generated from the combination of the acid of the Salt with the inflammable principle of the Iron. Great

part

URINE.

part of the mixture rises up in froth, which when cold appears a vitreous scoria, covered on the surface with a kind of metallic skin, which on being rubbed changes its green colour to a yellowish. The rest of the Iron remains at the bottom of the crucible, half melted, half vitrefied, and spongy. (5.) Tin lost eighteen grains, or near one half its weight, and rendered the Salt whitish; the remaining metal being at the same time remarkably changed. It was all over leafy and brilliant, very brittle, internally like Zinc: Laid on burning coals, it first begun to melt, and then burnt like Zinc or Phosphorus. (6.) Lead lost sixteen grains, and gave the same whitish colour to the scoriæ that Tin does. The remaining Lead was in like manner inflammable, but burnt less vehemently than the Tin; from which it differed also in retaining its malleability. (7.) Mercury precipitated from Aqua fortis and well edulcorated, being treated with the Salt in a glass retort with a fire raised to the utmost, only twelve grains of Mercury sublimed, twenty-eight remaining united with the Salt into a whitish semi-opake mass. A solution of this mixt in distilled water deposited a quantity of a yellowish powder, which by distillation in a glass retort was in great part revived into running Mercury: A part of the Quicksilver remained dissolved also in the clear liquor; for a drop, let fall on polished Copper, instantly whitened it. (8.) Regulus of Antimony, melted with the vitreous Salt, lost eight or nine grains, (about one fifth): The Regulus assumed a fine brilliant striated appearance; the scoriæ were somewhat opake. (9.) Bismuth lost eight grains: The scoriæ were like the preceding, but the Bismuth itself suffered little change. (10.) Zinc mixed with the Salt, and distilled in a glass retort, yielded a true Phosphorus, which arose in a very moderate heat. The residuum was of a grey colour, a little melted at the bottom, in weight not exceeding two drams, so that two scruples had sublimed. This residuum, urged further, in a small Hessian crucible, to perfect fusion, emitted an infinity of phosphorine flashes, with a kind of detonation: The matter, grown cold, looked like the grey scoriæ which arise in the fusion of common Glass. (11.) White Arsenic, mixed with this Salt, separated in the fire, greatest part of it subliming, and only so much remaining behind as increased the weight of the Salt eight or ten grains. This compound appeared at first transparent, but on being exposed to the air became moist, and of an opake whiteness, much resembling crystalline Arsenic. (12.) Cinnabar totally sublimed, suffering no change itself, and occasioning none in the Salt. Sulphur did the same. (13.) One part of the Salt mixed with ten of Manganese, and melted in a close vessel, gave a semitransparent mass, some parts of which were bluish. The crucible was lined with a fine purple glazing, and the edges of the mass itself appeared of the same colour.

The vitreous Salt dissolved also, in fusion, metallic calces and earths. Chalk, with one third its weight of the Salt, formed a semitransparent vitreous mass: Calcined marble, with the same proportion, flowed so thin as to run all through the crucible: Gypsum likewise run mostly through the crucible; what remained was semitransparent: Lapis specularis (*Marien-glas*) run entirely through the vessel: Spanish Chalk gave a semitransparent mass, which sparkled on breaking; and fine white Clay, a similar one: Saxon Topaz and Flint were changed into beautiful opal-coloured masses; the earth of Alum into a semitransparent, and Quick-lime into an opake white one. The mass with Flints imbibed moisture from the air; the others not.

Oil of Vitriol, poured upon one fourth its weight of this Salt in a retort, raised an effervescence, acquired a browniſh colour, and afterwards became turbid and white. On raising the fire, the Oil of Vitriol distilled, and the matter in the bottom of the retort melted. In the neck was found a little Sublimate, which grew moist in the air; as did likewise the remaining Salt, which was opake and whitish---Concentrated spirit of Nitre, distilled with this Salt in the above proportion, came over unchanged; no Sublimate appeared; the residuum looked like Glass of Borax. The distilled spirit did not act in the least upon Gold even by coction--Strong Spirit of Sea-salt being distilled in the same manner, no sensible change was made either in the Spirit or the Salt.

Equal parts of the vitrified microcosmic Salt and of Salt of Tartar being urged with the strongest fire that a Glass retort would bear, nothing sensible came over, nor did the

There are conſiderable differences in Urine, from the ſeaſon, aliments, or temperature of the body. It is generally paler and more dilute in winter than in

URINE.
Its differences.

the mixture appear in thin fuſion. Diſſolved in water, filtered, and ſuitably evaporated, it afforded, very difficultly, oblong cryſtals, ſomewhat alcaline, the quantity of Alcali having been more than enough to ſaturate the microcoſmic acid. A whitiſh matter remained on the filter, amounting to ſeven or eight grains from two drams of the mixture: This, after being waſhed and dried, melted before a blow-pipe; as did likewiſe the cryſtals.

This Salt ſeems to extricate in part the acids of vitriolated Tartar, Nitre, and Sea-ſalt. (1.) On diſtilling a mixture of it with an equal quantity of vitriolated Tartar, there came over ſome ponderous acid drops, which ſaturated with fixed Alcali formed a neutral Salt greatly reſembling the vitriolated Salt. The reſiduum readily diſſolved in water, and difficultly cryſtallized. (2.) Nitre treated with the ſame proportion of the Salt begun to emit red vapours. The reſiduum was of a peach-bloſſom colour, appeared to have melted leſs perfectly than the preceding, and diſſolved more difficultly in water. The ſolution depoſited a little earthy matter, and on being ſlowly evaporated, ſhot into cryſtals, which did not deflagrate in the fire. (3.) Sea-ſalt diſtilled in the ſame manner, manifeſtly parted with its acid. The reſiduum was whitiſh, readily diſſolved in water, and afforded ſome cubical cryſtals. (4.) Sal ammoniac ſuffered no change. Borax, with an equal quantity of the vitreous Salt, run all through the crucible.

Solutions of this Salt precipitated the earthy part of Lime-water, of ſolution of Alum, of Flint diſſolved in fixed Alcali, and the *liquamen ſalis ammoniaci fixi*, or concentrated ſolution of Chalk or Quick-lime in the marine acid. The Precipitate obtained from this laſt liquor is tenacious like Glue, and does not diſſolve even in boiling water: Expoſed to a ſtrong fire, it froths prodigiouſly, and at laſt melts into a thick ſcoria.

Solutions of this Salt precipitate alſo ſundry metallic ſolutions, as Butter of Antimony; ſolutions of Silver, Copper, Lead, Iron, Mercury, and Biſmuth, in the nitrous acid; and of Tin in Aqua regis. The Precipitate of Iron from Spirit of Salt is a tenacious maſs: That of Silver from Aqua fortis, ſometimes a white powder, ſometimes tenacious: Copper from Aqua fortis is ſometimes thrown down in form of a white powder, and ſometimes in that of a green Oil, according to the proportions and diluteneſs of the liquor. Silver is not precipitated at all by this acid from its ſolution in Vinegar, nor Gold from Aqua regis.

An ounce of the vitreous Salt well mixed with half an ounce of Soot, and committed to diſtillation, yielded a dram of fine Phoſphorus. The black reſiduum being elixated with boiling water, and the liquor paſſed through a filter; there remained upon the filter eight ſcruples of black matter, and on evaporating and cryſtallizing the liquor, about ſeven drams were obtained of oblong cryſtals, which did not deliquiate in a moiſt air, but became powdery in a warm one. Theſe cryſtals, treated afreſh with inflammable matter, yielded no Phoſphorus. Before a blow-pipe, they melted into a tranſparent globular maſs, which on cooling became turbid and opake. Diſſolved in water, they precipitated ſolutions of Silver, Mercury, Copper, and of Chalk, though they did not act upon the latter ſo powerfully, nor produce with it a gluey maſs, as before they had been deprived of their phoſphorine acid.

The author from whom we have taken theſe curious experiments, ſuppoſes, that the origin of the microcoſmic Salt is in the vegetable kingdom; that it actually exiſts, all but its volatile alcaline part, in ſundry vegetable ſubſtances, and is thence communicated to the Urine of animals. He finds that the ſeeds of Rocket, Creſſes, Muſtard, and even Corn, on being urged with a vehement fire, afford a true Phoſphorus, and of conſequence muſt contain the phoſphorine acid: And that human Urine yields more of the microcoſmic Salt in ſummer, when vegetable foods are uſed moſt freely, than in winter: This difference, however, may depend, not upon the difference of food, but upon the Urine being more dilute in one ſeaſon than in the other.

URINE. in ſummer, and in young perſons than adults. By diſeaſes, it is ſo much influenced, that in many caſes the appearance of the Urine is an uſeful aſſiſtance to the phyſician in forming a judgment of the diſtemper. Such as is voided in the morning, or many hours after eating or drinking, is for obvious reaſons the moſt ſaturated.

How far its quality is affected by particular aliments or liquors, is not clear: There are ſubſtances which communicate to it a manifeſt impregnation; thus Aſparagus gives a fetid ſmell, and Turpentine a violet one; Rhubarb and Turmeric a deep yellow colour, and the pulp of Caſia fiſtularis, a greeniſh or blackiſh one: But that the drinking of Wine or Beer occaſions any remarkable difference, as the ancients ſuppoſed, there is little ground to preſume.

Its nature, Recent perfect Urine is not ſenſibly alcaline or acid; but in keeping, it ſoon begins to putrefy and acquire an alcaline quality; and this change it ſometimes undergoes before its diſcharge from the body. By putrefaction, its marine Salt is in part deſtroyed or volatilized; and hence after diſtilling putrefied Urine, we obtain from the Caput mortuum much leſs of that Salt than when freſh Urine is uſed, and this in proportion as the putrefaction has been carried to a greater or leſs length.

and uſes. Urine is made uſe of in ſundry chemical arts; as in dying, ſcouring, making Alum, Sal ammoniac, Nitre, *&c.* It has ſometimes been employed in the ſhops as a precipitant for certain ſolutions: A *Lac* or white Precipitate is thrown down by it from a ſolution of Sulphur made by boiling Sulphur in water along with Quick-lime; and a roſe-coloured Precipitate, from a ſolution of Quick-ſilver in the nitrous acid.

Diſtillation of Urine. The volatile ſpirit and Salt of Urine are uſually prepared, by putrefying the Urine in large wooden tubs, and then diſtilling it with a gentle heat gradually increaſed. If the fire is raiſed a little too haſtily, it ſwells up and boils over: This inconvenience may be prevented by rubbing the upper part of the veſſel all round with Tallow.

Some dephlegmate the putrefied Urine in open veſſels, and then proceed to the diſtillation of the remaining thick matter; but in this proceſs, a good deal of the ſubtile ſpirit is loſt. The Urine may however be advantageouſly dephlegmated before putrefaction, either by fire, or what is ſtill more commodious where the ſeaſon will permit, by freezing; for only the aqueous parts congeal, and by the ſeparation of theſe, the remainder becomes proportionably more faturated.

By adding Quick-lime to the inſpiſſated Urine a cauſtic volatile ſpirit is obtained, without putrefaction, ſimilar to that prepared by the ſame intermedium from Sal ammoniac: By this addition, the volatile ſpirit is extricated without the application of any external heat; the inſpiſſated Urine growing hot when mixed with the Quick-lime, and this heat being ſufficient to elevate a conſiderable part of the volatile penetrating ſpirit.

The rectification of the Spirit, Salt, and Oil of Urine, is performed in the ſame manner as of thoſe of other animal ſubſtances. I have had an Oil of Urine, which taſted as ſweet as Sugar. From the Caput mortuum is obtained, by elixation with water, the Sea-ſalt; and by calcining and then elixating it, a fixed alcaline one. I have prepared from this ſubject two fixed alcalies, differing

ing from one another; one groſſer, and the other more ſubtile. The marine Salt alſo is more ſubtile than common Sea-ſalt: On diſtilling the entire Caput mortuum with the addition of ſuch ſubſtances as extricate the acid of Sea-ſalt, there ariſes an acid ſpirit, ſimilar in its general properties to the marine, but in ſome reſpects different from it. URINE.

THE Phoſphorus of Urine, called emphatically Phoſphorus, by ſome *Phoſphorus urens*, *phoſphorus glacialis*, *noctiluca glacialis*, *noctiluca aerea*, was caſually diſcovered, about the year 1669, by one Krafft, a German chemiſt. Soon after, Kunckel prepared it; and one Brand, having procured ſome pieces, though unacquainted with the method of making it, went into England, France, &c. and arrogated to himſelf the honour of the diſcovery. At length Mr. Boyle and Mr. Homberg found out the ſecret; and Godfrey Hanckwitz, then operator to Boyle, improved, refined, and perfected the Phoſphorus. Phoſphorus: Its hiſtory,

The Phoſphorus is obtained by diſtilling in a ſtrong fire either inſpiſſated Urine, or the Caput mortuum remaining after its diſtillation in the common manner. Some additional matters are generally mixed with the inſpiſſated Urine; Homberg uſes red Bole; Boyle, white Sand; and Boerhaave, powdered Charcoal. An account of the manner of conducting the proceſs may be ſeen in the Memoirs of the French Academy and other books. If we have a good furnace, and a retort that will ſtand a fierce fire, there is no difficulty in obtaining the Phoſphorus in ſmall grains, like Millet-ſeed or Lentils: But in preparing it into fine large white ſticks, like pieces of tobacco-pipes, no one has hitherto ſucceeded like Mr. Godfrey. It congeals, at the bottom of the recipient, like the ice of dirty water in kennels, and requires a further purification from its brown and blackiſh matter (*u*). preparation.

A good

(*u*) *Proceſs for Phoſphorus.*] Mr. Hellot, in the Memoirs of the French Academy for the year 1737, has given a very particular account of the moſt ſucceſsful manner of conducting this operation. If his directions are carefully followed, it will be impoſſible, he ſays, to miſcarry.

A large quantity of Urine, after ſtanding to putrefy for at leaſt five or ſix days, is to be evaporated in an iron kettle, till the matter grows thick and black: It is then to be kept conſtantly ſtirring, to prevent its forming a hard incruſtation upon the veſſel, till it is reduced into a ſhining, black, clotty, powdery ſubſtance, like Soot.

This dry reſiduum is to be calcined in an iron pot, by five or ſix pounds at a time, with a fire ſufficient to make the veſſel red-hot. The calcination is to be continued, and the matter kept ſtirring, till it has loſt almoſt all its volatile Salt and fetid Oil, that is, till it ceaſes to ſmoke, and acquires a ſmell like that of Peach bloſſoms.

The calcined matter is to be freed from the ſuperfluous marine Salt of the Urine (which ſeparating and melting in the diſtillation, would corrode the retort) by elixation with water. To every pound, put a pint and a quarter of water; ſtir them together, and let them ſtand for twenty-four hours; then decant off the ſaline liquor, and dry the remaining powder.

Sixty gallons of Urine leave on evaporation about ten pounds of dry matter. This loſes in the calcination about one third its weight, and in the elixation about one half of the remainder; and thus is reduced to three pounds or three and a half; a quantity ſufficient for one diſtillation, and which will yield an ounce or more of Phoſphorus.

Three pounds of the elixated powder are to be mixed with a pound and a half of coarſe Sand, and four or five ounces of powdered Charcoal. The Sand ſhould not be that of rivers, for this crackles and flies about when ſtrongly heated; nor the Char-

URINE. coal that of Oak, which is accompanied with the ſame inconvenience. The mixture is to be moiſtened with about half a pound of water, and made into a maſs, to be put into a Heſſian retort of ſuch a ſize that one third of it may remain empty. The common earthen-retorts or long-necks are incapable of ſtanding the intenſe fire requiſite for this operation.

Before we proceed to the diſtillation, it will be proper, for the greater ſatisfaction and ſecurity, to make an aſſay of about an ounce of the mixture in a ſmall crucible made gradually red-hot. If it has been duly prepared, it will ſmoke and crack, without ſwelling or riſing up: White or bluiſh undulating flames will ariſe impetuouſly from the cracks: On placing upon the crucible, when theſe diſappear, a large piece of lighted Charcoal, the true Phoſphorus will diſcover itſelf in a ſteady, luminous, ſomewhat violet-coloured vapour, covering the whole ſurface, and ſmelling ſtrongly of Garlic. When this vapour is diſſipated, pour the hot matter upon an iron plate: If no particle of Salt can be ſeen in it, we have nothing to fear; but if any drop of Salt has melted out and appears diſtinct, the elixation with water muſt be repeated or the retort will be in danger.

The retort, charged with the mixture, is to be placed in a reverberatory furnace, ſo conſtructed as to be capable of giving as fierce a heat as that of the glaſs-houſe furnaces. Adapt to the retort a large glaſs receiver filled to one third with water; and ſecure the juncture with a mixture of tobacco-pipe Clay and drying Oil, over which is to be ſpread ſome common lute moiſtened with a ſolution of Glue.

It is indiſpenſibly neceſſary that the juncture be perfectly tight; but it is equally neceſſary that an exit be allowed to the elaſtic vapours, which otherwiſe would infallibly burſt the veſſels. If we endeavour to give them vent by an upright tube inſerted in the luting, as is cuſtomary in other operations, the heat of this part of the veſſel would fire the ſubtile phoſphorine vapours that ariſe firſt, and theſe would kindle the true Phoſphorus which ſucceeds. An aperture is therefore to be made in the further part of the receiver itſelf, about four or five inches above the ſurface of the water: This is the grand ſecret in the whole proceſs. It will be eaſy to contrive means of grinding a ſmall hole through the glaſs with Emery; which hole is to be fitted with a little birchen plug furniſhed with a knob to keep it from ſlipping in.

The apparatus having ſtood for three or four days, till the luting is dry; and the cracks, if any have happened, being repaired; proceed to the diſtillation. This laſts commonly four and twenty hours. Mr. Hellot begins at two in the morning, by putting an unlighted coal into the aſh-hole, and a lighted one at the door, which kindles the other. By gradually ſupplying a little more fuel in the aſh-hole, the furnace and luting become thoroughly dry, and the phlegm of the mixture diſtils. At ſix, ſome coals are laid on the grate; which being ſoon kindled by the fire underneath, the receiver grows warm, and is filled with white fetid vapours. At ten, theſe vapours diſappear, the receiver grows cool, and the fire is to be increaſed and ſteadily kept up. About noon, a ſaline ſubſtance, different from the common volatile Salt of Urine, begins to concrete in elegant ramifications all over the internal ſurface of the recipient, and is by degrees diſſolved and waſhed down by the ſteam of the water in that veſſel. About three after noon, the receiver is filled with freſh vapours, which ſmell like Sal ammoniac thrown on burning coals, and which condenſe into ſaline ſtriæ not diſſoluble by the ſteam of the water. Theſe are the forerunners of the Phoſphorus, and towards the end of their diſtillation they loſe the ammoniacal and acquire a phoſphorine or Garlic ſmell. As they come over with great rapidity, the aperture in the receiver muſt now be frequently unſtopt; and if the vapour hiſſes forth impetuouſly, the heat muſt be diminiſhed by cloſing up the air-draughts of the furnace. Theſe white vapours continue about two hours; after which the fire is to be raiſed, and kept up moderately ſtrong. About ſix, the more volatile phoſphorine fumes beginning to ariſe, the birchen peg rubbed upon any warm part of the furnace leaves a luminous tract; and ſoon after, there darts through the aperture in the receiver a ſtream of bluiſh light, which does not burn, but renders the hands luminous. On unſtopping the aperture from time to time, the luminous ſtream is obſerved gradually to lengthen to ſeven or eight inches;

inches; and afterwards to grow ſhorter, to crackle, ſparkle and burn. In about two hours from the firſt appearance of this volatile Phoſphorus, the ſmall jet of light contracts to the length of one or two twelfths of an inch: There is now no danger of the veſſel's burſting; puſh the fire boldly to the utmoſt extremity, and for ſix or ſeven hours keep up ſuch a white heat, that the retort cannot be diſtinguiſhe'. In this extreme degree of heat, the true Phoſphorus comes over, in the form of Oil or melted Wax, partly ſwimming upon the water in the receiver, and partly ſinking to the bottom. At length the upper part of the recipient, where the volatile Phoſphorus had condenſed into a black film, begins to grow red; a mark that the Phoſphorus is there burnt, and that the operation is finiſhed. The furnace is now to be ſhut up cloſe, and the aperture in the receiver ſtopt with Fat, Lute, or melted Wax. All the empty part of the receiver appears luminous till the veſſels are grown cold.

When the whole is become thoroughly cold (not before, leſt the Phoſphorus ſhould take fire) ſeparate the receiver, and expeditiouſly wipe out the black matter about its mouth, which mingling with the Phoſphorus would injure its tranſparency. A quantity of cold water is to be poured into the receiver, to waſh out and promote the ſettling of the Phoſphorus; and the whole poured into a clean earthen pan. The cold water being decanted off, ſome boiling water is to be added to melt the Phoſphorus, which now forms a maſs of a ſlate colour, to be broke in pieces, when cold, in freſh cold water.

The Phoſphorus is purified and formed into ſticks, by melting it in boiling water in glaſs tubes. The neck of a matraſs, having its mouth or lower aperture ſtopt with a cork and greateſt part of its body cut off, forms a convenient veſſel for this purpoſe. The tube being filled with the boiling liquor, throw in the pieces of Phoſphorus, which ſoon liquefy and ſink to the bottom: Stir the liquid matter with an iron wire, to promote the ſeparation of the impurities, and keep the water boiling till, on taking out the tube, the Phoſporus appears clear and tranſparent. The tube being then cooled a little in the air is to be plunged in cold water, to make the Phoſphorus congeal. The ſtick is to be puſhed out at the wider end of the tube, and the impure part at top cut off. URINE.

Mr. Hellot ſays, that from three pounds and a half of the calcined and elixated matter he obtained ſix ſticks of Phoſphorus, each four inches long, weighing in all nine drams and ſome grains, at leaſt equal in quality to that made by Mr. Godfrey; and that he was informed that Mr. Godfrey uſed a receiver with a vent-hole, and inſtead of inſpiſſated Urine the ſettlings procured from the dyers. In caſe of accidents from the Phoſphorus taking fire, he finds nothing to extinguiſh it but Urine.

THERE is one ſtep in this proceſs, which requires further examination, and which, ſo far as I can judge from the experiments that have as yet been made, is rather prejudicial than uſeful. We have formerly ſeen that Urine contains a certain fixed acid Salt, of a peculiar kind; and that the Phoſphorus conſiſts of this acid combined with inflammable matter. Now as this Salt diſſolves eaſily in water, it ſhould ſeem that the elixation of the calcined Urine could not fail to ſeparate a great part of this eſſential ingredient, as well as the marine Salt of the Urine; and in effect, the ſaline liquor diſcovers, upon trial, plain marks of the microcoſmic or phoſphorine Salt.

More than double the above quantity of Phoſphorus has been obtained, in leſs time and with leſs fire, by *adding* certain ſaline ſubſtances to the inſpiſſated Urine, inſtead of *ſeparating* any of its native Salts. This diſcovery was firſt made by Henckel, in treating calx of Lead with Sal ammoniac, Salt of Tartar, and ſtale Urine, in a view to the reſolution or mercurification of the metal. Mr. Marggraf has re-examined and proſecuted the experiment, and found *ſaturnus corneus*, or a combination of Lead with the marine acid, to be the beſt addition.

Saturnus corneus is moſt commodiouſly prepared by mixing Sal ammoniac with twice its weight of Minium, and expoſing them to a moderate heat: The volatile Alcali of the Sal ammoniac is extricated, and its marine acid remains combined with the ſaturnine calx into a brittle reddiſh maſs.

Nine or ten pounds of inſpiſſated Urine, about the conſiſtence of thin Honey, were ſet to evaporate further in an iron pot; three pounds

URINE. A good deal of caution is requiſite in all operations with this inflammable concrete: Mr. Godfrey himſelf, notwithſtanding his large experience, was once in danger of his life from it, his hand being burnt ſo terribly, that for a time he was out of his ſenſes, and for three days lay in exquiſite pain, as if his hand had been conſtantly in a fire.

and properties. This Phoſphorus is ſet on fire by rubbing as well as by the application of actual heat; and burns far more vehemently, and with a more piercing heat, than any other known ſubſtance. Expoſed to a temperate air, it appears luminous like a burning coal, and emits a continual offenſive ſmoke, till the whole quantity is diſſipated. Characters drawn with it on paper or other ſubſtances, appear alſo, in the dark, as if they were on fire. It is very ſlowly conſumed; a ſingle grain diffuſing a ſeemingly burning light for fifty hours together.

Though this concrete takes fire ſo readily when rubbed by itſelf, it does not fire at all by grinding it with other inflammable bodies, as Camphor, Gunpowder, or eſſential Oils. In grinding it with Nitre, ſome luminous flaſhes are obſerved, but the mixture never burns, unleſs the quantity of Phoſphorus be large in proportion to the Nitre. Rubbed pretty hard on a piece of Paper or Linen, it ſets them on fire if they are rough, but not if they are ſmooth: It fires written Paper more readily than ſuch as is white, probably from the former

pounds of the above Saturnus corneus in powder, and half a pound of powdered Charcoal, gradually mixed in; and the whole kept ſtirring, till reduced into a dry blackiſh powder. This, urged with a red heat, gave over a ſmall portion of urinous ſpirit and an ammoniacal Sublimate; after which it was pulverized afreſh, in order to the more perfect mixture of the ingredients. A little of it, being examined on burning coals, gave inſtantly an arſenical or phoſphorine ſmell, and an undulating blue flame.

With the powder thus prepared, were charged, to three fourths of their capacity, ſix earthen pint retorts; the fire acting to better advantage upon a number of ſmall veſſels, than on a large one equivalent to them. To each retort was luted a glaſs receiver, ſomewhat more than half filled with a pint of water, which was made almoſt to touch the end of the neck of the retort. The fire being gradually raiſed, and kept up ſtrong for an hour and a half, the Phoſphorus came over in drops which being collected and purified, amounted in all to two ounces and a half of as fine Phoſphorus as can be made. The whole continuance of the diſtillation was but four hours and a half.

Luna cornea had much the ſame effect as Saturnus corneus. With Calamine alſo the quantity of Phoſphorus was larger than the Urine by itſelf would have afforded.

THE acid of Phoſphorus agrees in ſome of its properties with the marine acid, and is ſuppoſed by the chemiſts to be at bottom no other than the marine, altered a little by the admixture of ſome other matter.

As the vitriolic acid forms with inflammable matter common Sulphur, and the nitrous a compound which deflagrates in the cloſeſt veſſels the very inſtant it is formed; ſo the marine is held to produce, with the ſame inflammable principle, this ſingular ſpecies of Sulphur, more inflammable than the one, and leſs ſo than the other.

This theory, firſt advanced by Stahl, is countenanced by the phoſphorine flame which ariſes from common Salt thrown on burning coals. Hence trials have been made for procuring Phoſphorus without Urine, from common Salt or its acid and vegetable or animal inflammable matters; but hitherto without ſucceſs. And indeed the acid ſeparated from Phoſphorus, as we ſhall ſee hereafter, is in many of its properties extremely different from the marine, and from all other known acids or combinations of acids.

former having more aſperities. On grinding it with iron filings it preſently takes fire. URINE.

Oils, ground with Phoſphorus, appear like itſelf luminous in a temperately warm place, and thus become a liquid Phoſphorus, which may be rubbed on the hands, *&c.* without danger. Liquid Phoſphorus is commonly prepared, by grinding a little of the ſolid Phoſphorus with Oil of Cloves, or rubbing it firſt with Camphor, and this mixture with the Oil. A luminous Pomatum is obtained in the ſame manner, by uſing common Pomatum inſtead of the diſtilled Oil. A luminous amalgam, as it is called, is prepared by digeſting a ſcruple of the ſolid Phoſphorus, reduced into ſmall bits, with half an ounce of Oil of Lavender; and when the Phoſphorus begins to diſſolve, and the liquor to boil, adding a dram of pure Quickſilver; then briſkly ſhaking the glaſs for five or ſix minutes, till they unite.

Rectified Spirit of Wine, digeſted on Phoſphorus, extracts a part of it, ſo as to emit luminous flaſhes on being dropt into water: It is computed that one part of Phoſphorus will communicate this property to ſix hundred thouſand parts of ſpirit: The liquor has never been obſerved to appear luminous by itſelf, nor in any other circumſtance than that above-mentioned. By digeſtion for ſome months, the undiſſolved Phoſphorus is reduced into a tranſparent Oil, which neither emits light, nor congeals in the cold: By waſhing with water, it is in ſome meaſure revived; acquiring a thicker conſiſtence, and becoming again luminous, though in a leſs degree than at firſt. The operator ought to be on his guard during the digeſtion, as the glaſs is very apt to burſt. No menſtruum is as yet known, that readily and perfectly diſſolves this concrete. Dr. Cyprianus hit once on ſuch a menſtruum, but never could ſucceed again (*x*).

With

(*x*) *Solubility*, &c. *of Phoſphorus.*] This concrete diſſolves partially in expreſſed Oils, and totally or almoſt ſo in eſſential Oils and Æther: When eſſential Oils are ſaturated with it by heat, a part of the Phoſphorus ſeparates on ſtanding in the cold, in a cryſtalline form.

Concentrated Spirit of Salt has no action on it; in diſtillation, the ſpirit ariſes firſt, and the Phoſphorus after it, unchanged.

Spirit of Nitre diſſolves it: The action of this acid is accompanied with great heat and copious red fumes, inſomuch that great part of the ſpirit diſtils without the application of any external heat, and the Phoſphorus at laſt takes fire, explodes, and burſts the veſſel.

Oil of Vitriol likewiſe diſſolves Phoſphorus, but not without a heat ſufficient to make the acid diſtil: The diſtilled liquor is thick, white, and turbid; the reſiduum is a whitiſh tenacious maſs, which deliquiates, but not totally, in the air. Phoſphorus itſelf is reſolved into an acid liquor on being expoſed for two or three weeks to the air, its inflammable principle ſeeming by degrees to be diſſipated.

PHOSPHORUS has been reported to produce extraordinary effects in the reſolution of metallic bodies; but from the experiments that have been made in this view, it does not appear to have any remarkable action on them, at leaſt on the precious ones Gold and Silver, for the reſolution or ſubtilization of which it has been chiefly recommended. The following experiments were made by Mr. Marggraf.

1. A ſcruple of filings of Gold was digeſted with a dram of Phoſphorus for a month, and then committed to diſtillation. Part of the Phoſphorus aroſe, and part remained above the Gold, in appearance reſembling Glaſs: This grew moiſt on the admiſſion of air, and diſſolved in water, leaving the Gold unaltered.

2. Half

URINE. With regard to the compoſition of this Phoſphorus, one of its principles is apparently the concentrated inflammable ſubſtance of the animal Oil of the Urine: The other is the concentrated acid of the marine Salt of the Urine. The water, in which the Phoſphorus has been long kept, (for it is commonly kept in water to preſerve it from diſſipation,) is manifeſtly acid to the taſte, and on mixture with different ſubſtances is found to poſſeſs the general properties of acid liquors: On burning the Phoſphorus in a Silver veſſel, a quantity of acid remains behind (*y*).

IT

2. Half a dram of fine Silver precipitated by Copper being digeſted with a dram of Phoſphorus for three hours, and the fire then increaſed to diſtillation, greateſt part of the Phoſphorus aroſe pure, and the Silver remained unchanged.

3. Copper filings being treated in the ſame manner, and with the ſame quantity of Phoſphorus; the Phoſphorus ſublimed as before, but the remaining Copper was found to have loſt its metallic brightneſs, and to take fire on the contact of flame.

4. Iron filings ſuffered no change.

5. Tin filings run into granules, which appeared to be perfect Tin.

6. Filings of Lead did the ſame.

7. The red calx of Mercury, called Precipitate per ſe, treated in the ſame manner, was totally revived into running Quickſilver.

8. Regulus of Antimony ſuffered no change itſelf, but occaſioned a change in the conſiſtence of the Phoſphorus, which after being diſtilled from this ſemimetal, refuſed to congeal, and continued, under water, fluid like Oil Olive.

9. With Biſmuth, there was no alteration.

10. A dram of Phoſphorus being diſtilled and cohobated with an equal quantity of Zinc; greateſt part of the Zinc ſublimed in form of very light, pointed flowers, of a reddiſh-yellow colour: Theſe flowers, injected into a red-hot crucible, took fire, and run into a glaſs, reſembling glaſs of Borax.

11. White Arſenic, ſublimed with Phoſphorus, aroſe along with it in form of a mixed red Sublimate.

12. Sulphur unites readily with Phoſphorus, into a maſs which ſmells like Hepar ſulphuris. This does not eaſily take fire upon being rubbed; but expoſed to a moderate dry heat, it flames violently and emits a ſtrong ſulphureous fume.

(*y*) *Acid of Phoſphorus.*] The properties of this extraordinary acid, ſo far as they have hitherto been diſcovered, are theſe.

1. It is the moſt fixed of all acids, and is not volatilized by flame, ſince it remains after the burning of the Phoſphorus, and may be collected in notable quantity even in an open veſſel. If a veſſel is placed over the burning Phoſphorus, a quantity of light flowers concretes in it, which diſſolve in the air into an acid liquor ſimilar to that which remains in the lower veſſel.

2. On diſtilling off the phlegm of the acid liquor in glaſs veſſels, a ſolid ſaline ſubſtance remains; which on raiſing the fire melts into the appearance of Glaſs. The vitreous matter, urged with a blow-pipe on a piece of Charcoal, runs into a round bead, which rolls about like Silver in the cupel. Expoſed to the air, it ſoon grows moiſt, and by degrees runs into an acid liquor again.

3. This acid, ſaturated with pure fixed alcaline Salt, ſhoots into cryſtals; which, before a blow-pipe, do not crepitate like marine Salt, but bubble and boil like Borax, and then ſink into a pellucid vitreous bead.

4. Saturated with volatile Alcali, it ſhoots into oblong ſpicular cryſtals, which melt in nearly the ſame degree of heat that Lead does, and in a ſtronger fire part with their volatile Alcali, a ſemivitrefied ſubſtance remaining.

5. It totally diſſolves Zinc, Iron, Calx of Copper, and white Arſenic. Lead, Tin, and Copper filings, it diſſolves only partially. Silver and Gold it has no action upon at all.

6. Mixed

IT was in ſearching for alchemical ſecrets, that the Phoſphorus of Urine was diſcovered. The alchemiſts have ſearched alſo in the Alvine feces, but nothing of much importance has reſulted from the fulſome labour. Homberg obſerved that the fecal matter calcined with Alum proves a ſpecies of Phoſphorus, which takes fire on being expoſed to the air; but the ſame product is found to be equally parable from Alum and any other animal or vegetable inflammable matter. In ſome proceſſes, the human fecal matter has yielded a ſmell like that of Muſk or Civet: A tincture made from it in ſweet-ſcented waters or rather vinous ſpirits, evaporated by a gentle heat to a thick conſiſtence, is called by ſome *occidental Civet*. ALVINE FECES.

The dungs of different animals have been employed in medicine; not only for external purpoſes; but likewiſe internally, in the form of infuſion, ſpirituous tincture, and ſometimes of powder. As one of theſe differs remarkably from the other ſubſtances of this claſs, I ſhall give an account of the experiments I have made upon it.

Album-græcum, or the white dung of a dog that feeds upon bones, ſeems to conſiſt chiefly of the earthy part of the bones, and to have very little of a ſteracoraceous nature. ALBUM-GRÆCUM.

Half an ounce, digeſted with rectified Spirit of Wine, gave three grains of a blackiſh extract, which had neither ſmell nor taſte: The ſame quantity, boiled in freſh parcels of pure diſtilled water, gave twenty grains of extract, in colour blackiſh, in taſte quite ſaline like the watery extract of bones. The remaining powders had the ſame appearance as at firſt: In diſtillation, the ſpirit aroſe unaltered; and the diſtilled water had only a very ſlight kind of unpleaſant ſmell.

Spirit of Vitriol diſſolved a little of the *Album-græcum*, and acquired from it a yellowiſh tinge; but there was no appearance of the cryſtalline concretions, which

6. Mixed with a ſolution of Gold, it occaſions no turbidneſs or precipitation. After the liquor has ſtood for ſome time, a little of the Gold is depoſited in its bright metallic form. Mr. Marggraf relates, that upon diſtilling the mixture by a ſtrong fire, ſome obſcure yellow drops appeared; that the reſiduum was of a purple colour, and lightly covered with reduced Gold, and that before a blow-pipe it run with eaſe into an opake glaſs-like ſubſtance.

7. Silver, diſſolved in volatile Alcali, is precipitated by this acid of a yellow colour, not white as by the marine acid. The ſame metal, diſſolved in fixt Alcali that has been impregnated with animal inflammable matter, is precipitated by the phoſphorine acid of a red colour, whilſt the marine acid makes no precipitation at all.

8. Solution of Mercury in Aqua fortis is copiouſly precipitated by the phoſphorine acid, but on ſtanding greateſt part of the Precipitate is taken up again; what remains undiſſolved is a ponderous black powder. In diſtillation, a notable quantity of white ſhining matter is left, which before a blow-pipe melts into a pellucid glaſs: On continuing the flame greateſt part of the vitreous matter ſinks into the coal and ſmokes away.

9. Solution of Lead in Aqua fortis depoſites on the addition of the phoſphorine acid a white powder, which on ſtanding is not rediſſolved. The matter which remains upon diſtilling this mixture, melts by a blow-pipe into a beautiful pellucid glaſs drop, without fumes, and without any revival of the Lead.

ALBUM-GRÆCUM.

which uſually ſeparate from ſolutions of other animal earthy bodies made in this acid. Spirit of Nitre diſſolved nearly the whole, and Spirit of Salt about one half; both theſe became likewiſe yellowiſh. Spirit of Sal ammoniac, common alcaline Ley, and cauſtic Ley, extracted alſo a yellowiſh tincture, without diſcovering any further action.

Two ounces, diſtilled in a retort, gave over two drams and a half of clear water which had no ſmell or taſte, then one dram and a half of a yellow empyreumatic liquor, and afterwards half a dram of an empyreumatic Oil of a volatile ſmell: The Caput mortuum weighed one ounce three drams.

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